Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matter of	)	
	)	
Effects of Communications Towers	)	WT Docket No. 03-187
on Migratory Birds	)	

To: The Commission

COMMENTS

Citicasters Licenses, L.P. ("Citicasters"), the licensee of FM broadcast station KQLF, Cheyenne, Wyoming, and an indirect subsidiary of Clear Channel Communications, Inc., by its attorneys, hereby submits these comments in the above-captioned docket in response to the *Notice of Proposed Rulemaking* ("*NPRM*") 1/

The *NPRM* solicited comments on whether the Commission should take measures regarding communications towers and migratory birds. These Comments submit into the record the results of a scientifically-rigorous Avian Monitoring Project undertaken over a two-year period at the site of station KQLF's 500 foot, guyed communications tower in Larimer County, Colorado. 2/ The tower operates with medium-intensity white strobe lights during daylight hours; at night, red flashing lights are used in addition to non-flashing side marker lights. 3/ This avian study was conducted by Colorado State University and EDM International, Inc., to fulfill a permitting condition imposed by Larimer County, due to

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1/ 21 FCC Rcd 13241 (2006). Per *Order*, DA 07-172 (rel. Jan. 12, 2007), the comment date was extended to April 23, 2007.

2/ A copy of the Final report, entitled "Clear Channel of Northern Colorado Slab Canyon KQLF-FM Broadcasting Tower Avian Monitoring Project 2002-2004" ("Slab Canyon Avian Study") is attached hereto at Exhibit 1.

3/ Slab Canyon Avian Study at 9.

concerns regarding potential effects of the tower to resident and migratory birds. The study methodology involved: 1) weekly surveys at the tower site and a reference site during all seasons; 2) use of remote-control cameras to monitor for bird kills; 3) a scavenger removal study; and 4) a surveyor bias study. 4/

Over the two-year monitoring period, a total of eleven bird mortalities were detected at the KQLF tower site. 5/ Even when factoring in predator scavenging and surveyor search biases, the study concluded that"[f]ew bird mortalities were documented at Clear Channel's KQLF broadcasting tower during the 2-year monitoring period." 6/

Given the low bird mortality rate of this study, and of other studies in the record of this docket, Citicasters respectfully submits that the Commission does not have a reasoned, scientific basis at this time to conclude that additional measures should be implemented restricting the construction and/or lighting of communications towers to protect avian populations.

Respectfully submitted,

CITICASTERS LICENSES, L.P.

By: ______________________
Marissa G. Repp

HOGAN & HARTSON L.L.P.
555 Thirteenth Street, N.W.
Washington, DC 20004-1109
(202) 637-6845

Its Attorneys

April 23, 2007

4/ *Id.* at 5.

5/ *Id*. at 20.

6/ *Id*. at 28.

EXHIBIT 1

Final

Clear Channel of Northern Colorado Slab Canyon KQLF-FM Broadcasting Tower Avian Monitoring Project 2002-2004

Prepared for:

Clear Channel of Northern Colorado

and

Larimer County

Prepared by:

EDM International, Inc.
Lori A. Nielsen
4001 Automation Way
Fort Collins, Colorado 80525-3479
970/204-4001
lnielsen@edmlink.com

Colorado State University
Kenneth R. Wilson, Professor
Department of Fishery & Wildlife Biology
Colorado State University
Fort Collins, CO 80523
970/491-7755
kenw@ursus.cnr.colostate.edu

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TABLE OF CONTENTS

1.0 INTRODUCTION

1.1 Historical Background

As the U.S. demand for wireless communication and broadcasting has increased over the last few decades, the number of communication tower structures correspondingly has risen in response. The potential for bird collisions with these communication towers and the impact on avian populations from antennae operation have come under increasing scrutiny by regulatory agencies, the communication industry, avian specialists, environmental groups, and the public.

Historically, bird collisions with communication towers and their ancillary facilities have been recorded through direct observations, incidental mortality reports, and formal tower studies (Kerlinger 2000; Manville 2000a and 2000b). However, estimates of tower-related avian mortality vary widely. In part, the uncertainty associated with mortality estimates and the effect on both resident and migratory bird populations reflects the challenge of monitoring bird strikes at these sites.

Bird kills at tower sites were first documented in the U.S. in the late 1940s (Kerlinger 2000; Towerkill.com 2004). Initial studies on bird collisions at communication tower sites were conducted from the 1950s through the 1970s, with some studies continuing into the 1990s. However, on the night of January 22, 1998, an estimated 5,000 to 10,000 Lapland longspurs and other species were killed at three adjacent towers and a natural gas pumping facility in western Kansas (Berry 1998). This "mass mortality event" served as a catalyst to refocus on avian mortality at communication towers in the U.S. and subsequently to mobilize a number of actions in various sectors, from federal to local and from private to industrial, to further explore the magnitude of this problem.

Over the last 50 years, a number of incidental mortality records, scientific studies, and anecdotal observations have been reported pertaining to bird kills at and near communication tower sites (Kerlinger 2000). However, there are limitations in comparing these records due to the lack of continuity in study design (e.g., qualitative observations versus quantitative monitoring), data recording (e.g., anecdotal notes versus formal data records), and estimating biases (e.g., surveyor bias and scavenger removal rates). These factors have limited the ability to determine and compare the extent of avian mortalities, both spatially and temporally.

Additionally, there has been a geographic bias in communication tower studies with the majority being conducted in the eastern portion of the U.S. (Stoddard 1962; Kemper 1964; Taylor and Anderson 1973; Carter and Parnell 1978; Crawford and Engstrom 2001;). For example, Shire et al. (2000) found that of 47 studies only 14 (approximately 30%) were located west of the Mississippi River with none located west of the Rocky Mountains.

Two categories or types of bird kills are reported at communication tower sites. “Trickle kills” is a term used for the incremental mortality reports of low numbers of birds over time at tower sites, as compared to the “mass kills” that are more prominent in the literature and popular press. The extent and potential cumulative effects of trickle kills are poorly understood. As a basis for comparison, Table 1 lists incidental reports of mass mortality events that characterize the historical focus on single night, mass kills.

Table 1. Incidental reports of mass kills of avian species on single nights at various North American tower sites.

Date	Location	Tower Height (ft)	Bird Mortalities Reported	Citation
28 Sep 1956	North Carolina	788	2,500	Trott (1957)
16 Sep 1959	Illinois	988	1,000-1,500	Parmalee and Parmalee (1959)
Unk. date 1963	Wisconsin	1,000	12,000/1 night	Manville (2000a)
26 Sep 1968 28 Sep 1970	Tennessee	1,368	5,399 3,487	Nehring 2000; Nehring and Bivens 1999
29-30 Sep 1970	Florida	1,484	1,592; 859	Taylor and Anderson (1973)
30 Sep 1972	Tennessee (4 towers)	Tallest 125	>1,801	Herndon (1973)
2-29 Sep 1972	Illinois (7 towers)	605-1,587	110-992/night; 4,915 total	Seets and Bohlen 1977)
22 Sep 1974	New York	843	844	Welles (1978); Howard (1977)
5 Sep 1974	North Carolina	1,994	3,240	Carter and Parnell (1978)
9 Oct 1955 5 Oct 1957 17 Oct 1974 14 Sep 1975 15 Sep 1975	Florida	1,008	4,000-7,000 2,325 971 636 486	Stoddard (1962); Crawford (1978)
20-24 Sep 1977	New York	843	132-1,817; 3,862 total	Welles (1978); Howard (1977)
26 Sep 1985 1 Oct 1986 12 Oct 1986 9 Oct 1994	Kansas	1,440	919 635 834 420	Ball et al. (1995)
22 Jan 1998	Kansas	300-420	5,000-10,000	Berry (1998)
17 Oct 1990	Kentucky	1,000	>1,576	Elmore and Palmer-Ball (1991)

Although a number of studies have been summarized (Kerlinger 2000; Manville 2000b), several unknowns still exist regarding the potential impacts of communication towers on birds. The U.S. Fish and Wildlife Service (USFWS) initially published, “Human Related Mortality of Birds in the United States” (Banks 1979), which examined the majority of anthropogenic factors that can result in bird mortalities. Nationwide, human-caused mortality of birds was estimated at 196 million bird deaths annually from all factors (e.g., hunting; pest control; collisions with vehicles, buildings, overhead power lines, and communication towers; pollution, and poisoning) (Banks 1979). Hunting was the greatest direct mortality factor (61%) of human-related bird deaths. Collision with human-made objects was the greatest indirect mortality factor (32%). Banks (1979) estimated 1.25 million birds killed annually in the U.S. by communication tower sites, which represented approximately 1.9 percent of the estimated bird population in North America in 1979. Subsequently, Evans (1998) reassessed tower mortality based on increased numbers of tall towers, estimating 2 to 4 million bird deaths per year. Manville (2001b) estimated annual mortality at 4 to 5 million birds from a December 1999 evaluation, but indicated that mortality rates could range as high as 40 to 50 million (Manville 2001a), based on a December 2000 assessment. However, since few standardized bird collision studies have been completed in the U.S., how representative these extrapolated estimates may be for estimating avian mortalities is unknown.

1.2 Collision Risk Factors

The relative risk of birds colliding with aboveground structures, such as communication towers, can be attributed to a number of variables, such as topography, land features, elevation, resident and migratory bird species present, extent of migratory flyways, location of daily movement corridors, associated habitats, urban and suburban interface, degree of existing development, and climatic conditions (localized and regional). Neotropical migrants, particularly wood warblers, vireos, and thrushes, appear to be the most susceptible to collisions with communication towers. Neotropical migrants migrate between North America and Central/South America and many of these species migrate at night (Kerlinger 1995). Diurnal species most affected appear to be fast-flying species, such as waterfowl, other waterbirds, and certain species of raptors (e.g., falcons). Although mortalities of diurnal bird species have occurred at tower sites, the majority of the historical mortality records at tower sites are primarily comprised of nocturnal migrants.

Bird migration is a complex phenomenon that is a combination of orientational cues, such as the position of the sun, moon, and stars; the Earth's geomagnetic field; polarized light; topographical features; and continental outlines (Ogden 1996; Cochran et al. 2004). Evidence suggests that despite the multiple navigational cues available for certain bird species, individuals are likely opportunistic in the choice and implementation of these mechanisms, depending on conditions or location (Ogden 1996). Recent evidence by Cochran et al. (2004) suggests that birds may daily calibrate their magnetic compass using twilight cues at sunset before nightly migration flights.

The critical threshold for tower height has not been definitively determined relative to bird collision risks. Tower height appears to be a potential factor in the rate of bird collisions with towers, although there is considerable discussion regarding the importance of tower height to the risk of collision (Stoddard 1962; Manuwal 1963; Crawford 1971, 1978; Kemper 1996; Crawford and Engstrom 2001). Towers taller than 500 feet tend to be implicated in more of the mass kills reported for communication tower sites (see Table 1). However, few mortality studies and monitoring programs have examined "shorter towers" (500 feet and less). It also appears that height is only one variable among other factors that may be important, such as geographic location, proximity to bird movement corridors, and prevailing weather conditions.

Per Federal Aviation Administration (FAA) and Federal Communications Commission (FCC) regulations, tower lighting is required for structures taller than 199 feet. Lighting specified by the FAA has traditionally included steady red lights, flashing red lights, and/or white strobe lights. Historically, birds have appeared to be “attracted” to artificial light sources from lighthouses and buildings (Ogden 1996), which is currently a prominent theory. Although flight behavior studies have recorded nocturnal migrants altering their flight patterns, behavior, and vocalizations in proximity to different types of tower lighting (Cochran and Graber 1958; Avery et al. 1976; Evans 2000; Gauthreaux and Belser 2000), it is unclear whether birds are actually attracted to a light source and move toward it or whether the birds are “trapped” by the light during their nocturnal flights (Ogden 1996).

Certain colors and flash patterns may disorient flying birds, especially during inclement weather when tower illumination bounces and refracts off water droplets suspended in the air to create an aura of light and a greater illuminated space around the tower (Avery et al. 1976). Theoretically, birds enter the illuminated area around a communication tower during foggy or inclement weather and are reluctant to leave the illuminated area due to disorientation or a loss or change in some of their nocturnal navigational cues (Avery et al. 1976). As the birds circle or flutter in the lighted space, individuals begin to strike guy wires, the tower, or each other often resulting in direct mortalities or crippling effects. Others fall to the ground exhausted.

Most researchers and tower operators agree that most bird mortalities have been reported during or after weather events, including precipitation, increased frontal system winds, low cloud ceilings and visibility, and foggy conditions. However, the degree of association between climatic factors and bird kills is not completely understood. The correlation between bird kills and advancing cold fronts with lower cloud ceilings, increased winds, and lower visibility appears to be strong, particularly during autumn (Brewer and Ellis 1958; Norwoods 1960; Eaton 1967; Avery et al. 1977; Mollhoff 1983; Nicholson 1984; Kemper 1996). Some of the larger bird kills at tower sites occurred as birds moved into weather frontal systems from an area that was clear upon leaving that night or as weather systems overtook birds already migrating, forcing the birds to lower altitudes (Stoddard 1962; Welles 1978; Kemper 1996). Tail winds also can be a factor for increasing the avian collision risk with communication towers (Kemper 1996), even on clear nights (Stoddard 1962). Surveyors using acoustic monitoring have observed that rapid weather changes from overcast to clear conditions have resulted in the cessation of bird collisions (Avery et al. 1976; Kemper 1996).

Vocalizations by nocturnal migrants near towers have provided researchers additional information on the duration of a species’ presence, flight behavior, composition, and relative bird density (Kale et al. 1969; Evans 2000). Acoustical studies that support the “attraction” theory report migratory bird calls given while circling a lighted tower during low visibility and inclement weather cease and the birds leave the circle of light once the lights have been temporarily extinguished at the tower site (Cochran and Graber 1958; Avery et al. 1976). However, records of nocturnally migrating birds becoming confused by artificial lights also have been recorded during clear, calm nights (Ogden 1996).

2.0 PROJECT DESCRIPTION

In 2000, Clear Channel of Northern Colorado (Clear Channel) proposed to construct and operate a guyed, 500-foot radio broadcasting tower approximately 20 miles northwest of Fort Collins, Colorado in Larimer County (UTM 13 483508E 4527077N) (see Map 1). This project was initially referred to as the "Clear Channel of Northern Colorado KIGN Relocate Project" during the permitting review process; however, the project's name was revised and is presently known as the "Slab Canyon KQLF-FM Broadcasting Tower."

Clear Channel originally provided two reports as part of the permitting review process in 2001 that contained project specifics, applicable communications, and results from other project-related studies. During Larimer County's public comment period, local citizens, nearby residents, avian specialists, and environmental organizations expressed a high degree of concern regarding the potential adverse effects to both resident and migratory birds from tower operation. As part of the permitting conditions, Larimer County required a minimum 2-year avian monitoring project to determine collision risk to birds from the operation of this tower. This is the first project of this type conducted in Colorado and one of less than 20 studies completed to date west of the Mississippi River.

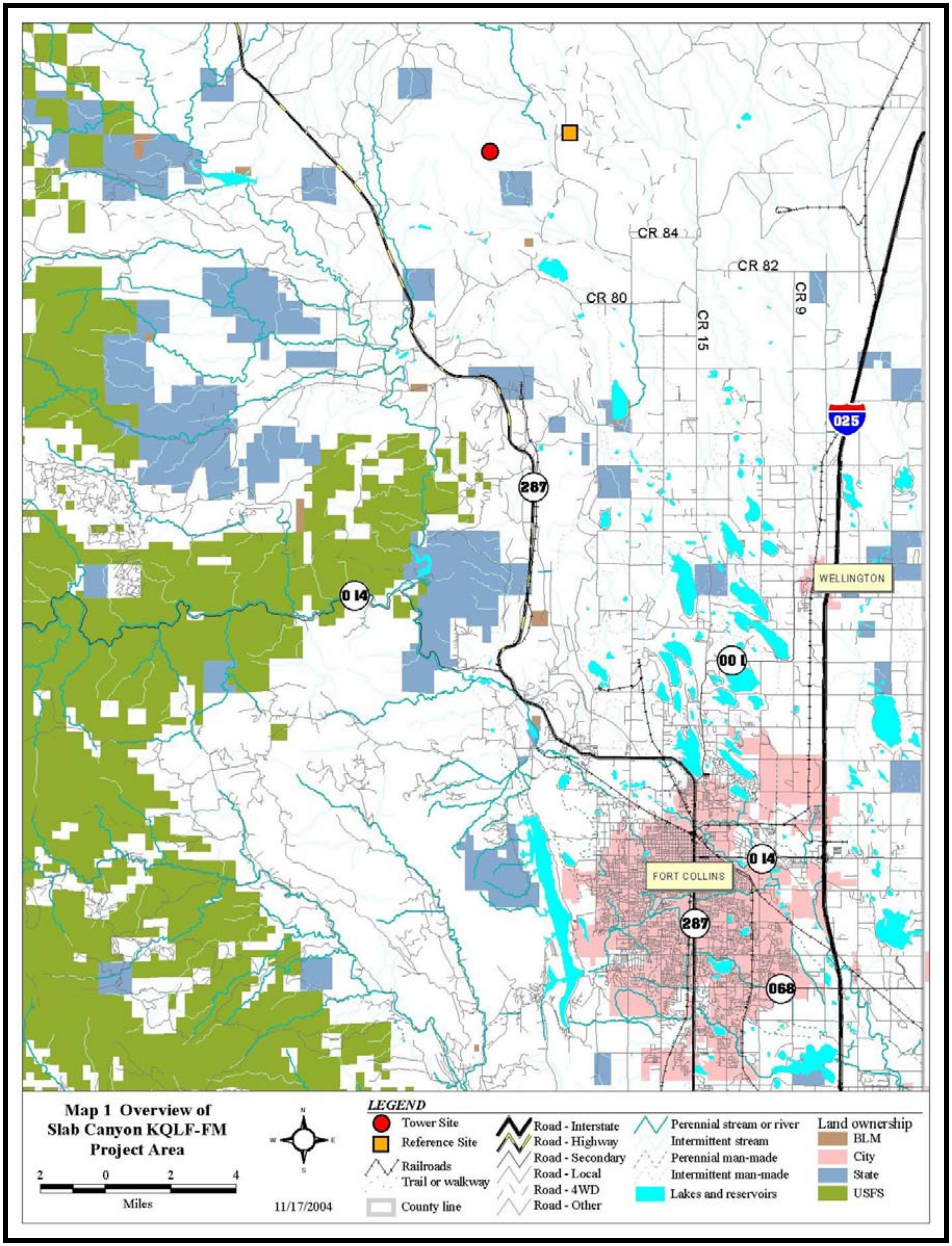
Clear Channel contracted with Colorado State University (CSU) and EDM International, Inc. to conduct this 2-year monitoring project. The monitoring plan that was developed incorporated: 1) weekly surveys at the tower site and a reference site during all seasons; 2) use of remote-control cameras to monitor for large bird kills, particularly following storm events; 3) a scavenger removal study; and 4) a surveyor bias study.

Tower construction was completed in the spring of 2002. The Slab Canyon KQLF-FM radio tower began transmitting 1 June 2002 and is accessed by a 2.7-mile road off Larimer County Road 23 that is maintained by Clear Channel.

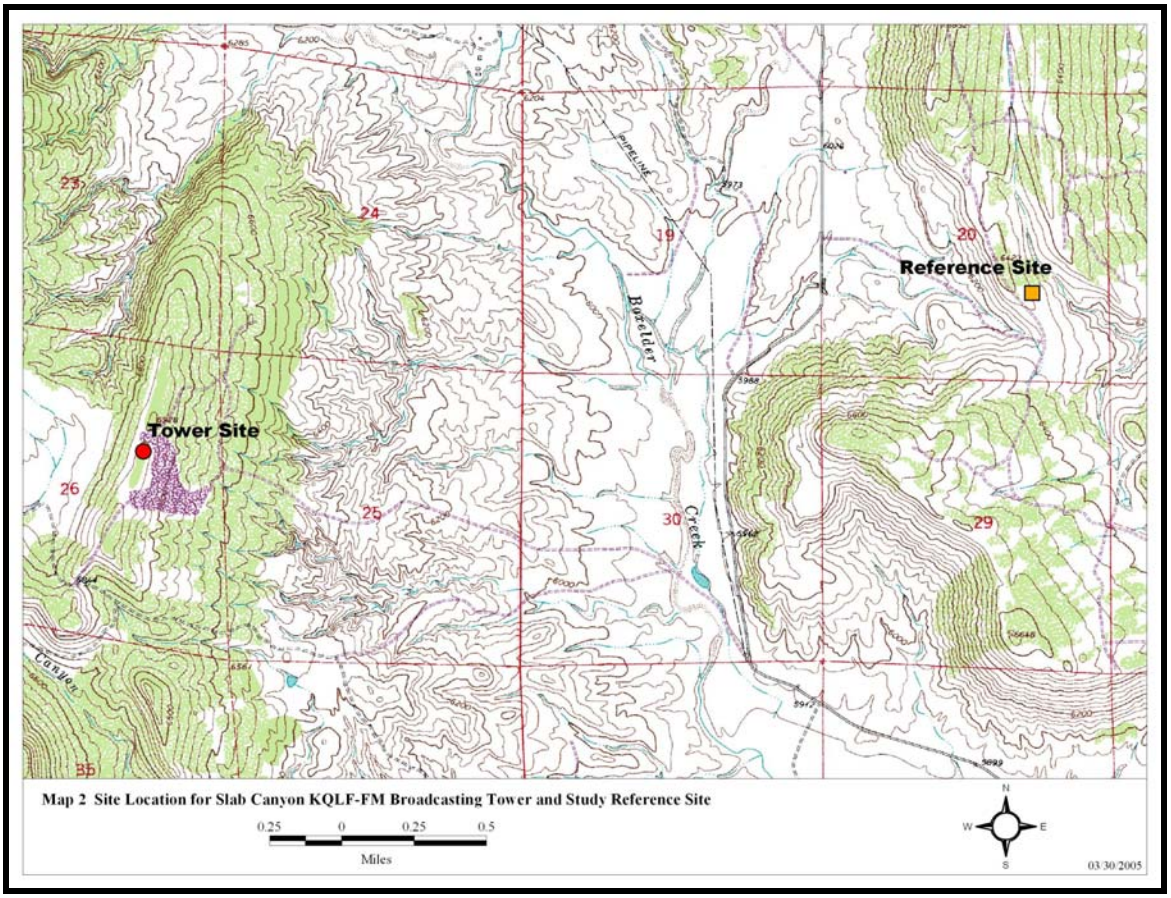
In the vicinity of the tower site, the vegetation transitions from shortgrass prairie habitat in the lower valleys to sloping shrublands along the foothill region. The tower is located on a 16-acre, previous limestone quarry site at a base elevation of 6,906 feet (see Map 2, Photo 1 and Photo 2). Exposed bedrock and sandstone with rocky scree and cobbles, large boulder berms, isolated herbaceous plant

Photo 1. Slab Canyon KQLF-FM 500-foot radio broadcasting tower on previous limestone quarry site.

cover, dense sloping mountain-mahogany (*Cercocarpus ledifolius*) shrublands, and scattered ponderosa pine (*Pinus ponderosa*) comprise the 16-acre tower study site (see Photo 3 through Photo 9)



Map 1. Overview map.



Map 2. Site map.

Photo 2. Equipment building.

Photo 3. North from tower base.

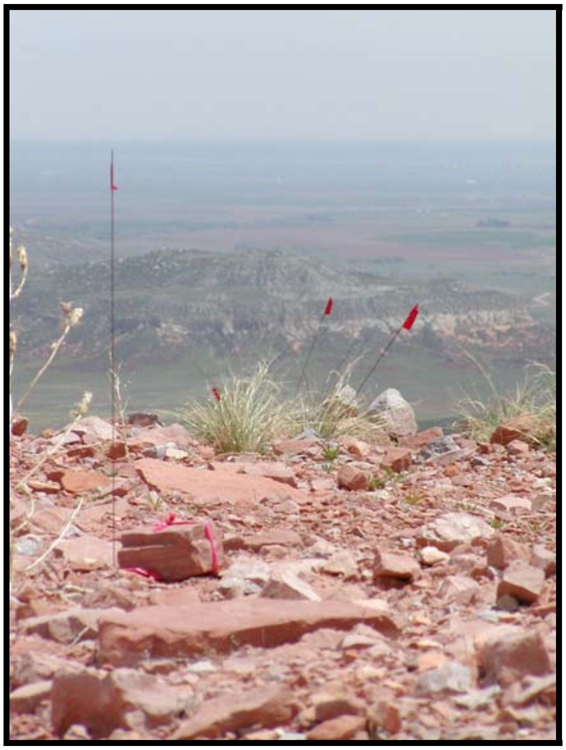


Photo 4. Rocky substrate and flagging system.

Photo 5. Southwest from tower base.

Photo 6. Northeast from tower base.

Photo 7. Sloping shrubland west of tower.

Photo 8. North-south trending ridgeline west of study site.

Photo 9. Foothills habitats transitioning to lower shortgrass prairie east of tower.

The tower is supported by 3 sets of 15 guy wires (1/2 to 13/8 inches) anchored at three concrete pilons that are 198 feet from the base and spaced at 120° around the tower (see Figure 1). The guy wires are attached at heights of 91, 181, 261, 341, and 421 feet.

During daylight hours, two L-865 medium-intensity white strobe lights at 40 flashes per minute (FPM) are used. At night, L-864 (720-watt) red flashing lights at 20-40 FPM are used, in addition to 116-watt side marker lights that do not flash. This lighting regime was based on public input received during the county scoping meetings and permitting process within the constraints of FAA regulations, which define the specific levels of lighting based on tower height. Local residents were opposed to white strobe lights at night because of aesthetics concerns.

Figure 1 Clear Channel Slab Canyon KQLF-FM Broadcasting Tower Profile

3.0 METHODS

3.1 <u>Survey Methods and Approach</u>

Survey methods for the Slab Canyon KQLF-FM tower site paralleled those used by Avery et al. (1975; 1977); however, certain study parameters were modified based on habitat and terrain. Unique, site-specific features of this tower site, such as the bedrock substrate occurring beneath the tower (see Photos 3, 5, and 6), allowed the use of innovative monitoring techniques, such as the remote-controlled cameras (see Section 3.3). However, other elements, such as extreme winds (60 to 80 mph at the tower site) limited other methods, such as catch netting to prevent removal of carcasses by terrestrial scavengers.

An area of approximately 10 ha (101,788 m^2) around the tower was surveyed. Sixteen 180-meter transect lines radiated from the tower center beginning at 0° and separated by 22.5° (see Figure 2). Transect lines were marked every 10 meters with flagging. A 60-meter radius circle around the tower base also was delineated with flagging.

Surveys were conducted weekly, depending on site access and weather, beginning 2 July 2002 and ending 3 July 2004. Surveys were completed year-round, although the focus was on migration periods when risks in other studies have shown to be greatest. In eastern Colorado, spring migration generally begins in early March and lasts through early June, while the fall migration generally occurs from August through October (Andrews and Righter 1992). Since weather conditions, such as fog, precipitation, and low cloud ceilings, have been correlated with greater numbers of kills (Brewer and Ellis 1958; Norwoods 1960; Eaton 1967; Avery et al. 1977; Mollhoff 1983; Nicholson 1984; Kemper 1996), additional site surveys were conducted following storm events during migration, when feasible (e.g., surveys were not conducted if unsafe conditions from snow, ice, or wind existed). Additionally, remote cameras provided opportunities to monitor the site following storm events (see Section 3.3).

The site surveyor attempted to complete a census (i.e., to detect every bird) within the inner 60-meter circle (11,310 m2) by traversing the tower center to the circle's edge in each of four quadrants (NE, SE, SW, NW). The 16 line transects were surveyed beginning at the outer edge of the 60-m circle to the end of each line (180 m from the center for 1,920 m of transects surveyed). Surveys searched for carcasses on or near the transect line using distance sampling methodology (Buckland et al. 2001). Areas around and on top of the equipment building and catwalk also were searched.

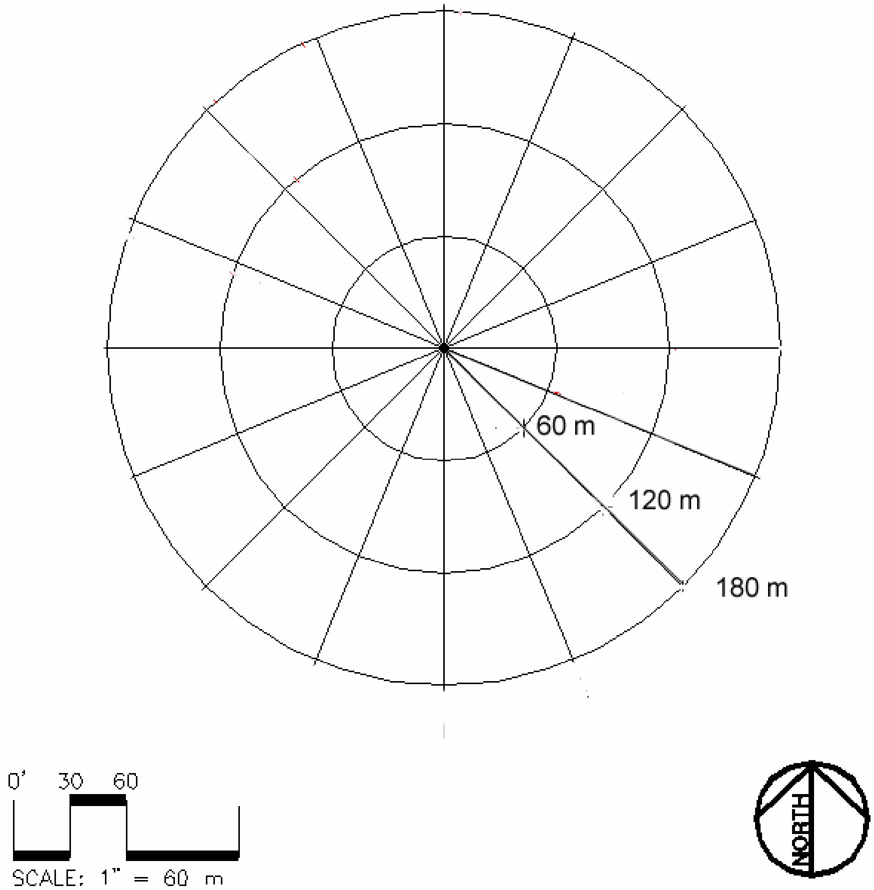


Figure 2. Layout of transects for avian mortality surveys at Clear Channel Slab Canyon KQLF-FM tower site.

Bird carcasses recovered during surveys were labeled, bagged, and frozen for identification. Collections occurred in accordance with EDM's federal and state salvage permits granted by the U.S. Fish and Wildlife Service (USFWS) and the Colorado Division of Wildlife (CDOW), respectively.

The following information was recorded for each bird mortality:

- Entry Number
- Date
- Bird identification number
- Time
- Line transect number
- Transect distance (approximate distance from the center of tower base)
- Quadrant (within the 60-m circle) or perpendicular distance to the line transect (outside of the 60-m circle)
- Whether on the right or left side of the line transect (with observer's back to the tower)

- Species
- Weather (precipitation, temperature, cloud cover, wind)
- Survey period (start and stop time)
- Surveyor

Bird species' identification was confirmed through either the federal Center for Disease Control (CDC) or Ronald Ryder (Emeritus Professor, Colorado State University). Carcasses were then submitted to the CDC for West Nile Virus testing, to assess the relative incidence of this expanding disease in migratory birds.

Weather data were obtained for the entire 2-year period from the National Climatic Data Center (NCDC) of the National Oceanic and Atmospheric Administration (NOAA). Precipitation and temperature measures were taken from the Virginia Dale weather station (Virginia Dale 7 ENE, approximately 5 miles north-northwest of the tower site), and the Fort Collins weather station (Fort Collins NW 9, 16.1 miles south of the study site), while wind and visibility measures were taken from the Fort Collins-Loveland Airport weather station (Fort Collins-Loveland Municipal Airport weather station, 32.7 miles south of the tower site). Wind and visibility records were not available for the first 24 days of the study period, and precipitation and temperature data were not available from the Virginia Dale station for late June 2003 and all of August 2003. Precipitation data from station Fort Collins NW 9 were substituted for these dates, but the temperature data were not available.

3.2 Reference Site

A reference site was established 2.5 miles from the tower site, extending from approximately 6,300 to 6,400 ft in elevation. The reference site was developed to compare numbers of avian mortalities between two ecologically similar areas in the absence of a tower (UTM 13 488291E 4528133N) (see Map 2). Ideally the reference site would have been on a nearby ridge, but none was accessible.

Reference site surveys were initiated on 15 September 2002 and were completed on 26 June 2004. The reference site was surveyed on the same day as the tower site, weather permitting. Because of the exposed terrain, fast-moving thunderstorms during the summer, and limited visibility during winter storms, surveyors were instructed to first complete the tower site survey, and thus on some occasions the reference site was not surveyed.

The habitat and aspect for the reference site are similar to the tower location, encompassing sloping shrublands and shortgrass prairie grasses and forbs. The survey protocol for the reference site was similar in that line transects (2,980 m total length) were surveyed using line transect methodology, but there was no census area. The lines were laid out in a rectangular grid to facilitate surveying (see Figure 3). Distance sampling methodology (Buckland et al. 2001) was used when surveying the lines and any bird mortalities were to be recorded as at the tower study site.

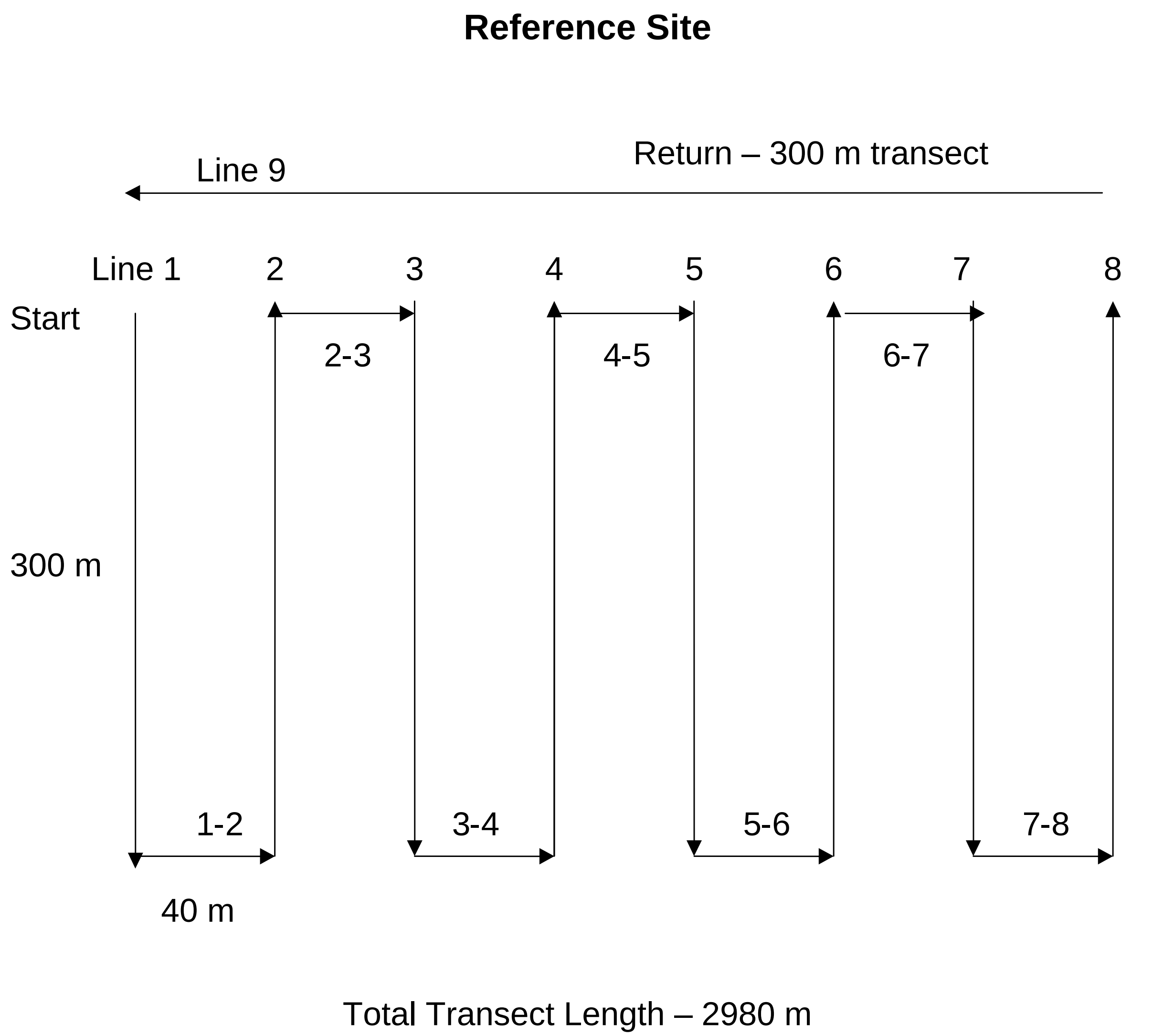


Figure 3. Layout of line transects at reference site for avian mortality surveys near Clear Channel tower study site.

3.3 Remote Cameras

Because of the isolated location and the unique bedrock substrate below the tower, remote-controlled cameras were installed to monitor the tower site in addition to the weekly site surveys. The flat bedrock substrate provided a good to excellent background to monitor for bird mortalities via web-based cameras (i.e., netcams), particularly for mass mortality events.

Initially, three digital IP-addressable netcams were suspended on the tower structure, scanning the full 360° surrounding the tower base (see Figure 4). The cameras used in this installation were Canon VB-C10R, each housed in a climate-controlled pod (see Photo 10 and Photo 11). Each camera had a 13V DC power line and an RJ45 network cable from the pods to the transmitter building. Inside the transmitter building, network cables ran to a 10/100 ethernet switch, which was connected to the satellite router for TCP/IP connectivity. The internal IP addresses on the satellite network were translated to outside accessible addresses, allowing observers to monitor the tower site any time during daylight hours.

Photo 10. Web-based cameras mounted on tower.

Photo 11. Camera in climate-controlled pod.

The cameras ran on a Linux webserver, and a login/password system was used to allow camera viewing and control. Camera access over the Internet was initiated with a Windows application using a TCP/IP protocol connection. Observers could remotely control each camera via the web site, allowing cameras to pan, tilt, and zoom. This enabled good resolution of the substrate and potential detection of bird carcasses beneath the tower. Maximum digital image quality was 640x480 resolution, but to increase response time for each camera, they were operated at a display setting of 320x240 and a quality setting of 3 to optimize bandwidth and allow smooth camera control.

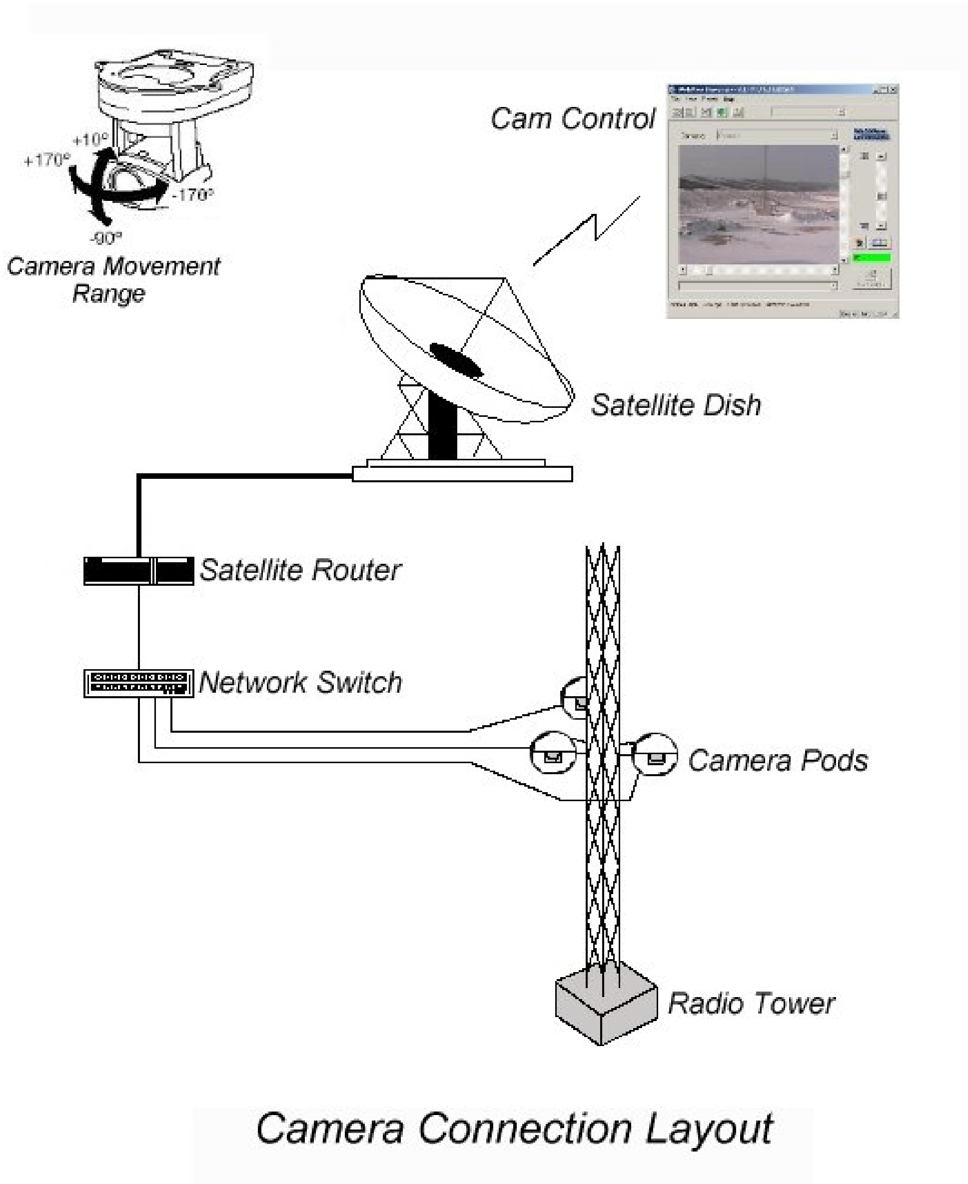


Figure 4. Tower connections and weblink for three remote-control Canon VB-C10R cameras.

The specific camera specifications are listed in Table 2:

Table 2. Canon VB-C10R specifications.

Optics	16x zoom lens
CCD (resolution)	410,000 pixels
Operating System	Linux
Protocols	TCP/IP, HTTP, BOOTP, FTP and Web View
Video compression	Motion-JPEG 1-5 variable video Quality - JPEG for stills
Video transmission rate	0.1 to 30 fps (variable)
Display sizes	160x120, 320x240, 640x480 pixels
Control	Pan, tilt, zoom, brightness, shutter speed, focus mode, view restrictions, control time limit
Network	Ethernet RJ45 10/100 auto negotiation
Operating Environment	Temp: 0-40°C Humidity: 20-85% relative humidity
Weight	730g
Power supply	AC adapter 25W or less (13v DC 1.8A camera)

Technical and operational difficulties during camera installation prevented camera use during the fall 2002 migration period. These problems were resolved, and the netcams became operational on 7 January 2003. Subsequently, the cameras were damaged by a lightning strike April 2003. Following repairs, the cameras resumed operation September 2003 through July 2004.

3.4 Carcass Removal Rate Study

In conducting a study of this nature, potential survey biases include: 1) scavenger or predator removal (i.e., carcasses that are removed prior to surveys); 2) searcher efficiency (i.e., birds missed during area searches); 3) habitat conditions (i.e., steep rocky crevices that cannot be searched); and 4) bird crippling (i.e., birds that may be crippled by tower collision but fall outside the search area). Any one of these biases could result in lower estimates of mortality at a tower site.

Predation or removal of bird carcasses by scavengers can significantly affect estimated mortality levels. In some areas of bird kills at communication tower sites, scavenger removal is rapid and aggressive (Stoddard 1962; Kale et al. 1969; Crawford 1971; Kemper 1996; Crawford and Engstrom 2001).

To estimate carcass removal rates and associated bias (due to scavenging and possibly decomposition), a scavenging removal study was completed during the fall migration near the project reference site from 26 September to 3 October 2002 and at the tower site from 11 to 17 March 2003. Frozen quail obtained from a commercial source were used to determine scavenging and carcass decomposition rates. In each survey, 100 quail carcasses of two size categories, 50 two-week-old (juvenile) and 50 eight-week old (adult) quail, were placed and monitored for an 8-day period.

For this study, 12 carcasses were placed along each of 8 parallel lines (n=96), with 1 additional carcass placed on 4 of the lines (n=100). Each line was 100 meters and at least 50 meters apart. Half of the transects were placed in grassland habitat and half placed in the sloping shrubland habitat above the grassland basin. For each line, a carcass was offset 5 meters perpendicular to the line at 4 meters and then every 8 meters (see Figure 5). Two-week-old birds were placed on transect lines 1-4 and 8-week- old birds on lines 5-8. Small pin flags that included the line number and the distance along the line were placed approximately 30 cm from each carcass.

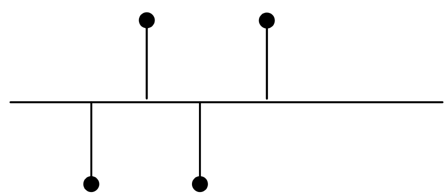


Figure 5. Diagram of 5-meter offset for carcass placement.

The second scavenger removal study was completed at the tower site in spring 2003. Eight of the 16 existing transect lines (lines 2, …,16) that radiated from the tower base were used (see Figure 2). The same procedure as in the first scavenger study was used to place carcasses along the 8 lines, except that each carcass was at 10 m apart beginning at the 10 m point (n=96). Two of the 4 extra carcasses were placed at the tower base (0 meters) and 2 were placed at 130 meters on lines 2 and 4. Each carcasses was again offset 5 meters perpendicular to the transect line (see Figure 5). Flagging wrapped around rocks, approximately 30 cm from the carcass, was used to mark each carcass location. The transects were surveyed daily for 7 days. The surveyor recorded if the carcass had been “Removed,” “Partially Eaten,” “Moved,” “Decayed,” “Other,” or a combination, e.g., moved and partially eaten. Because several quail carcasses remained at the tower site after the 7-day survey period, the carcasses were left in place, and two additional surveys occurred on 29 March and 7 April 2004. The remaining quail carcasses were then removed.

Program MARK (White and Burnham 1999) using the known fate model was used to analyze the “survival” of carcasses as a function of the two sizes of quail. The known fate model is commonly used to analyze survival eggs in nests. Four scavenging rate models were examined based on the data: 1) scavenging rate varied over time and by size (2-week-old vs. 8-week-old quail), 2) scavenging rate varied over time only, 3) scavenging rate varied by size only, and 4) scavenging rate was constant, i.e., did not vary by time or size. An information theoretic approach was used to select the “best” of these four models, as supported by the data (Burnham and Anderson 2002). A carcass could be exposed to scavenging for up to 7 days, if a mortality occurred just after the surveyor left. On average if a mortality occurred it would occur 3.5 days prior to a survey; we thus used estimates of the scavenging rate over 4 days to adjust the actual number of carcasses detected by season, i.e., fall versus spring.

3.5 Surveyor Bias Study

The surveyors attempted to census the 60-m radius area around the tower, but the ability to census wild animals alive or dead is virtually impossible. Several factors contribute to such bias such as surveyor heterogeneity (e.g., differences in search image, diligence, eyesight, and fatigue), terrain, and environmental conditions. On 10 September 2004, we estimated variations in surveyor bias using eight observers.

Fifteen bird carcasses of various species were randomly placed within the 60-meter circle around the tower's base. Eight observers independently surveyed the 60-meter area, recording each carcass observed and an associated carcass number (carcass numbers were hidden and did not attract the surveyors attention). Each surveyor was given 30 minutes and surveyed in a clockwise direction. In two 30-minute sessions, two surveyors began at the same time but at opposite sides of the tower and it was apparent that they could not easily see each other.

Program MARK (White and Burnham 1999), using closed capture-recapture models, was used to estimate the "probability" of detecting a carcass. Closed capture-recapture models (Otis et al. 1978) allow the probability of detection to be modeled as a function of heterogeneity (i.e., the individual surveyors), time (over the 1-hour survey period), and behavior (if finding a carcass by one individual affected the later detection by another individual). Heterogeneity might be expected in our study, because each individual had their unique search strategy, ability, etc. We did not expect time variation because there were not changes in conditions over the hour of surveying, e.g., weather conditions did not affect visibility of carcasses over time. Behavior might be a problem if observers could see each other or if previous observers were leaving clues to the location of a carcass or covering a carcass so that it was more difficult to detect by others. None of these seemed to be a possibility. After adjusting for the number of carcasses scavenged, the detection probability was then used to further adjust the estimate of the number of carcasses detected by dividing the number of detections by the detection probability.

4.0 RESULTS

4.1 Tower Monitoring Site

From 2 July 2002 to 3 July 2004, 11 bird mortalities were detected at the KQLF tower site (Table 3). Of the eight species identified as part of the mortality monitoring effort, six species are nocturnal migrants. The remaining two (common grackle and Brewer's sparrow) are local breeders that migrate or move diurnally. See Appendix A for detailed survey results.

Table 3. Bird mortalities recorded at Clear Channel Slab Canyon KQLF-FM broadcasting tower site between 2 July 2002 and 3 July 2004.

Date	Quadrant (w/in 60 m)	Transect Distance (meters)	Common Name	Scientific Name	Comments
12 Sep 02	SE	11	American coot	*Fulica americana*	Juvenile; broken wing.
27 Apr 03	SE	50	Lincoln's sparrow	*Melospiza lincolnii*	
4 May 03	SE	11	Common grackle	*Quiscalus quiscula*	Scavenged; feathers only.
12 May 03	NE	30	Swainson's thrush	*Catharus ustulatus*	Directly below NE guy wires.
27 May 03	SW	45	Swainson's thrush	*Catharus ustulatus*	
6 Jun 03	NW	30	Brewer's sparrow	*Spizella breweri*	
27 Jun 03	SE	40	Yellow-headed blackbird	*Xanthocephalus xanthocephalus*	Scavenged; wing only.
1 Sep 03	NE	32	House wren	*Troglodytes aedon*	
15 Sep 03	NE	40	Mourning warbler	*Oporornis philadelphia*	First plumage; sex unknown.
22 Sep 03	SE	52	Unknown		Feather spot only.
29 May 04	SE	10	Swainson's thrush	*Catharus ustulatus*	

Precipitation and temperature data were not available from the Virginia Dale station for late June 2003 and all of August 2003, so precipitation data from Fort Collins NW 9 station were used on these dates. Temperature data, however, were still not available.

For this study, weather days were only included in our summary if any of the following criteria were met:

- More than 5-degree (°F) change in average temperature.
- Any precipitation (rain or snow).
- More than 10-knot change in wind speed.
- Any wind gusts of more than 20 knots.
- Any decrease in visibility (visibility in clear conditions is 10 square miles).

With only 11 bird mortalities detected during the study period, correlations between recorded weather conditions and mortality occurrences are limited (Appendix Figures B1 through B6). However, the weather data provide some anecdotal value.

We assumed that a mortality occurred some time during the period prior to the survey date, typically a 1-week period. However, since the actual mortality date is unknown, the mortality may not be related to the previous period's weather event. For any precipitation periods when mortalities did occur there were similar periods with no mortalities.

Precipitation measures varied widely (Figures B1-B6). All carcass discoveries followed some precipitation event (Figure B1). Four discoveries of mortalities occurred after snow events (Figure B-2), and for four mortalities both snow and rain were recorded during the preceding intervals (27 April and 12 May 2003 and 22 September and 29 May 2004, Figures B1 and B2). Two mortalities were discovered following intervals with no available temperature data (27 June and 1 September 2003), plotted as 0 change in temperature (Figure B-3). During the nine other mortalities, temperature changed from between 5°F and 14°F.

Unfortunately, the closest wind recordings are from the Fort Collins-Loveland Municipal Airport located 32.7 miles south of the tower site, where the maximum wind speed during this 2-year period was 30 knots (35 mph). Estimated winds and wind gusts during the surveys ranged up to 50 mph (Appendices A and C, see Figures B4 and B5). In general, the foothills of the Colorado where the tower was located can experience much higher winds, and, adjacent area readings for this foothill region recorded winds up to 70 to 90 mph, although no formal wind metering station is located in the proximity to the tower site. Every day in the study period had some wind recorded, minimum 5 knots, except the first 24 days of the study period when no wind data was available. The average wind speed over study period was 15 knots. All mortalities were discovered following intervals of some wind, at least 13 knots. Nine mortalities were discovered following intervals with maximum wind speed above the average of 15 knots. No wind gusts were recorded on 169 days, plus 24 days with no available data (Figure B5). Wind gusts were recorded for 361 days (65% of the study period). However, since no formal wind monitoring station occurs in close proximity to the tower site, wind gust records are assumed to be low. All mortalities were discovered following intervals where wind gusts of at least 17 knots were recorded, and 8 occurred following intervals with maximum wind gusts above 25 knots.

Under normal conditions, visibility is 10 square miles. Any reduction in visibility from this norm is recorded as a decrease, e.g., visibility of 4 square miles is recorded as a decrease of 6 square miles (Figure B6). All mortalities were discovered following intervals of some decreased visibility, at least a 2-square-mile decrease. Nine mortalities were discovered following intervals with a maximum decrease in visibility of at least 5 square miles.

Most mortalities were discovered following intervals with significant weather measures in multiple categories (Figure B7). Rain precipitation events were recorded for all mortality intervals and were quite variable. Snow precipitation was recorded for only four mortality intervals. Changes in temperature of more than 5 °F were recorded for nine mortality intervals that had data, and no measures exceeded 50%. Significant wind speed was recorded for all the mortality intervals; all exceeded 40% of the maximum wind speed recorded, and eight exceeded 60%. Significant wind gusts were recorded for all mortality intervals; all were least 40% of the maximum wind gusts recorded, and eight exceeded 60%. A decrease in visibility was recorded for all the mortality intervals with five at 90% or above, four between 50% and 80%, and two below 50%. Maximum wind speed and wind gust values were the most consistently high over all mortality intervals. Decrease in visibility had the highest average value (72%) over all mortality intervals. From the graphs, wind speed, wind gusts, and decrease in visibility were consistently high over the mortality intervals. Combinations of various weather factors undoubtedly combine to produce conditions more favorable for a mortality event. A given wind speed or wind gust, for example, may present a greater hazard to birds flying near the tower under conditions of decreased visibility than during clear conditions.

4.2 Reference Site

Based on conversations with avian ecologists (R. Ryder, Colorado State University and M.B. Dillon, biologist) who had been involved in numerous surveys of avian species, few if any mortalities were expected at the reference site. Indeed, no bird mortalities were recorded during the 86 days at the reference site. This number was less than the 105 days at the tower site because priority was given to surveying the tower site on days when safety was in question. In addition, there were a few days when the road to the reference site was impassable due to road construction.

4.3 Remote Cameras

When available, cameras were used to monitor the tower site, particularly immediately following storm events during migration periods. The bedrock substrate located predominantly below the antennae structure made it possible to view bird carcasses. Because of difficulties experienced with the netcam installation and operation in the first few months of this study, remote-camera monitoring was not available during 2002. Additionally, the cameras were not operational between April and September 2003 due to damage caused by a lightning strike. Therefore, within the 24-month monitoring period, off-site monitoring via the remote-controlled cameras was available for 14 months or 58% of the time.

The intent of these cameras was two-fold: 1) monitor during periods when surveys were not planned or feasible and 2) detect bird kills prior to scavenging by predators. Although individual carcasses could have been detected within certain distances of the tower base, the emphasis of camera use were to detect mass mortality events, if they occurred.

Based on numerous trials, the digital image quality (set at 320x240 resolution) allowed good to excellent viewing within 50 meters of the tower; however, it would be difficult to detect small birds beyond 50 meters, unless a large number of mortalities were present. Another value of the cameras was the ability to easily monitor the equipment building roof and catwalk area. Remote cameras would not be feasible at sites with high vegetation or extreme topographical relief.

Photo 12 through Photo 17 provide representative views from the remote-control cameras when monitoring from off site via the satellite link. Each photo shows a screen shot embedded in the software, and also shows use of the zoom capability.

No bird mortalities were observed with the cameras during site monitoring, but it is believed that their resolution was sufficient to identify bird carcasses within 30 to 50 meters of the tower base and possibly further had a mass mortality event occurred.

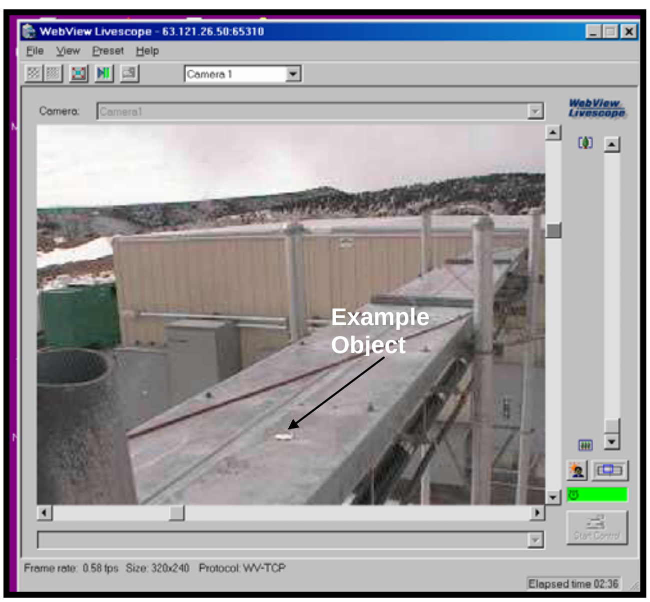


Photo 12. Camera 1 view of equipment building roof and catwalk (note object in foreground of catwalk).

Photo 13. Zoom of object on catwalk shown in Photo 12.

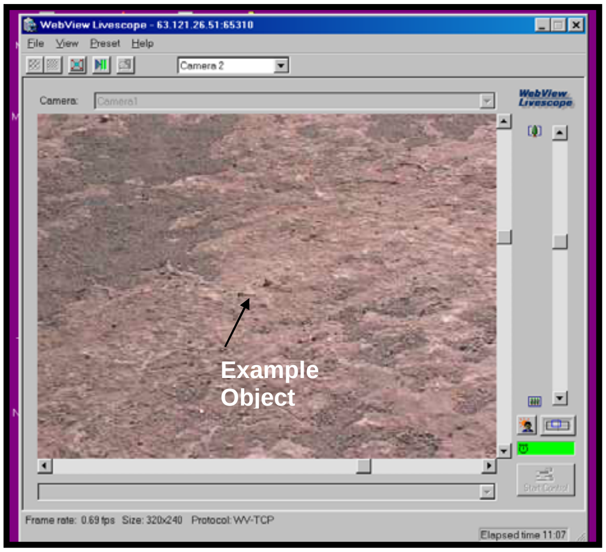


Photo 14. Camera 2 view of object approximately 30 meters from tower base.

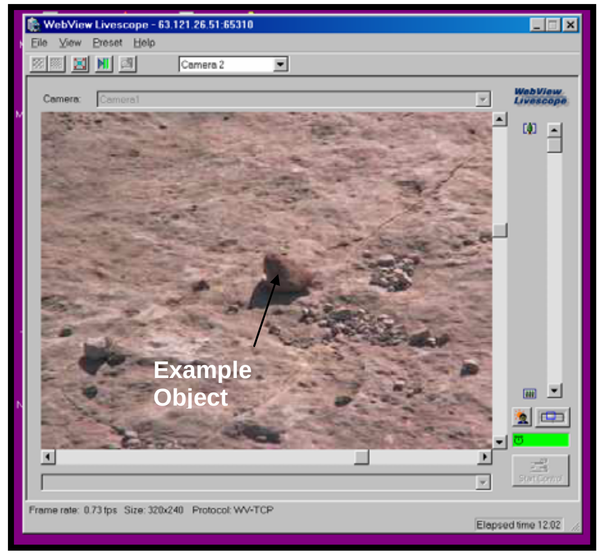


Photo 15. Zoom of object shown in Photo 14.

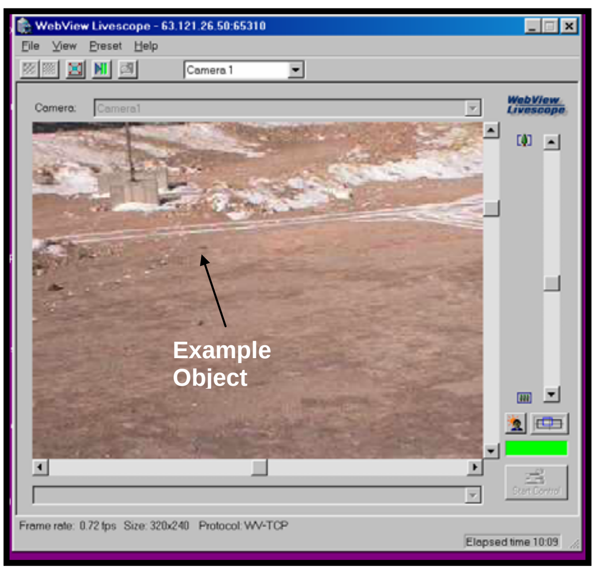


Photo 16. Camera 1 view of guy wire base with example object approximately 40 meters from tower base.

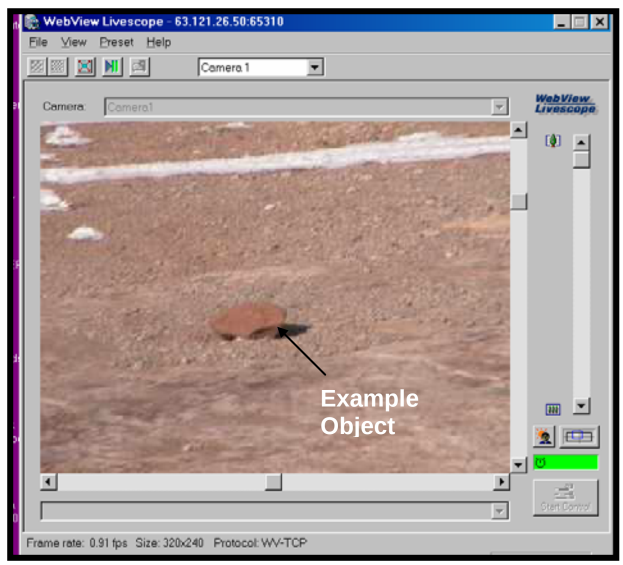


Photo 17. Zoom of object shown in Photo 16.

4.4 Carcass Removal Rate Study

For the fall 2002 carcass survey conducted off site, the best model suggested that scavenging varied over time but not by carcass age, i.e., 2-week-old versus 8-week-old scavenging rates had little variation (Table 4). Scavenging rates (S_c) were under 10% per day for the 1st four days with fewer than 50% removed, and then scavenging rates increased rapidly until all carcasses were removed by day 8. Temperatures were fairly warm during this period (80˚F on 23 Sept 2002, Appendix C).

Table 4. Carcasses removed off site in fall 2002.

Date	Carcasses Removed By Age 2 wk	8 wk	Daily % Removed	Cumulative % Removed	S_c[1]	Cumulative S_c
26 Sept	6	0	6	6	0.06	0.06
27 Sept	0	2	2	8	0.02	0.08
28 Sept	4	4	9	16	0.09	0.16
29 Sept	3	4	8	23	0.08	0.23
30 Sept	6	4	13	33	0.13	0.33
1 Oct	9	13	31	55	0.33	0.55
2 Oct	15	15	49	85	0.67	0.85
3 Oct	7	8	38	100	1.00	1.00
Totals	**50**	**50**				

[1] S_c – Scavenging rate.

For the spring 2003 carcass survey at the tower, the best model suggested that scavenging also varied over time but not by carcass age (Table 5). Only 18% (18) of the carcasses were scavenged after 6 days and scavenging rates (S_c) were less than 2% except for the 1st two days. After 19 and 27 days, scavenging rates increased, but even after 27 days only approximately 50% (49) of the carcasses had been scavenged or decayed. Official temperatures data was not available during the first 7 days, but the month of March was much colder than during the fall survey (30˚F on 1 March, 65˚F on 27 March, and 25˚F on 6 April, Appendix C).

Table 5. Carcasses removed at tower site in spring 2003.

Date	Carcasses Removed By Age 2 wk	8 wk	Daily % Removed	Cumulative % Removed	S_c[1]	Cumulative S_c
11 Mar	3	1	4	4	0.04	0.04
12 Mar	9	0	9	13	0.09	0.13
13 Mar	1	1	2	15	0.02	0.15
14 Mar	0	1	1	16	0.01	0.16
15 Mar	1	0	1	17	0.01	0.17
16 Mar	0	0	0	17	0.00	0.17
17 Mar	1	0	1	18	0.01	0.18
29 Mar	10	9	23	37	-[2]	-
7 Apr	6	6	19	49	-	-
Totals	**31**	**18**				

[1] S_c – Scavenging rate.
[2] scavenging rate estimated for first consecutive 7 days only.

The 4-day probability of a bird not scavenged was 0.23 (standard error (se) = 0.0421 and 0.440 (se = 0.084) during the fall and spring surveys, respectively. There were 4 and 7 mortalities during the fall and spring surveys, respectively (Table 3). The adjusted estimates by season are 17 (se = 1.68) and 16 (se = 0.59), respectively or 33 for the 2-year period.

4.5 Surveyor Bias Study

The weather was overcast, cool, windy, with slight rain when the surveyor bias study was conducted. No observers detected all the carcasses (Table 6). On average, 85% or 13 of 15 birds were detected by each observer with one observer detecting only 11 birds and two observers detecting 14 birds. The adjusted number of mortalities at the tower based on the 11 mortalities detected (Table 3) is 13 (se = 1.81). If the scavenger adjusted estimate of 33 is used then the total estimate is 39.

Table 6. Number of carcasses detected per surveyor at tower site on 10 September 2004.

Surveyor	Number of Birds Observed	Percent Observed
1	14	93
2	12	80
3	11	73
4	14	93
5	13	87
6	13	87
7	13	87
8	12	80
Mean	**12.75 (0.37)**	**85% (0.024)**

5.0 DISCUSSION AND RECOMMENDATIONS

5.1 Objectives

The Clear Channel's Slab Canyon KQLF-FM Broadcasting Tower study focused on determining the relative number of bird mortalities associated with operation of this 500-foot tower over a 2-year period. Since few studies have been completed on various types of communication towers in the U.S. and no long-term monitoring studies have been completed in Colorado, this monitoring program was the first to examine relative collision risk from the operation of a broadcasting tower to both resident and migratory birds in northern Larimer County, Colorado.

5.2 Discussion and Study Comparisons

5.2.1 Study Methodology

The communication industry is not unique in addressing avian issues or interactions with human-made structures. These avian interactions encompass issues associated with electrocutions from electric distribution power lines and collisions with power lines and wind turbines. Because of the increasing number of communication towers in the U.S. over the last few decades and the increased interest and scrutiny by regulatory agencies, the public, and organizations such as the Communication Tower Working Group, the FCC is currently reviewing bird interaction issues with communication towers and has requested public and industry input (FCC 2003, 2004). As part of this review, there is an attempt to standardize tower study methodology in order to directly compare bird collision studies conducted at different communication tower sites across the nation. The KQLF study design incorporated methods from previous studies (Avery et al. 1975, 1977) and ongoing research recommendations made by the Communication Tower Working Group, e.g., inclusion of a scavenger removal study and surveyor search bias. However, study methods continue to evolve as new information becomes available from research.

For example, the use of remote-control cameras for the KQLF tower study is unique for communication tower projects. As discussed in Section 4.3, these cameras would only be of value for sites with open habitat that allows easy detection of carcasses. The cameras were considered integral to this study, given the tower's remote location, survey frequency, and environmental conditions (e.g., snow depth, ice, wind, lightning). The use of cameras helped to increase the probabilty that an individual carcass and, more importantly, a mass mortality event would be detected between the weekly survey periods. Additionally, it allowed the surveyors to view the tops of the equipment building and tower catwalk.

5.2.2 *Avian Mortality Numbers*

Seasonal patterns in bird mortalities at communication tower sites have typically shown a pronounced spike during fall and spring migration (Brewer and Ellis 1958; Caldwell and Wallace 1966; Kemper 1996). The fall and spring spikes are presumably due to the large number of migrating birds, and in the fall greater numbers of young, inexperienced birds also may contribute to mortality numbers. Advancing cold fronts in both seasons often are associated with increased avian mortalities and may hasten migration in the fall and slow migration during the spring. Additionally, these weather fronts typically include low visibility, winds, and overcast conditions, which all appear to increase bird collision risk with towers. The KQLF tower study attempted to survey every week over the 2-year period. Other studies often concentrate site surveys during either migration period or following mass mortality events. Since no communication tower study had been completed in Colorado prior to the KQLF tower review, it was beneficial to record the seasonal pattern for mortalities, as discussed below.

Few bird mortalities were documented at Clear Channel's KQLF broadcasting tower during the 2-year monitoring period, even when factoring in predator scavenging and surveyor search biases. Additionally, no mass mortality events were recorded during this time. The mortalities recorded at the KQLF tower occurred primarily during the migratory periods. Of the 11 mortalities recorded, 9 birds were considered to be migrants and 2 (i.e., common grackle and Brewer's sparrow) were classified as local residents, with 6 of the mortalities occurring during the spring migration, 1 during early summer, and 4 mortalities during the fall migration period.

In reviewing certain aspects of reported tower kills and associated monitoring studies, noting the absence of mortalities may be as important as noting the presence of large numbers of bird mortalities (Stoddard 1962), i.e., understanding the height, configuration, lighting regime, and habitats of towers without mortalities also is important. For example, monitoring only those towers associated with reported collisions and bird mortalities will limit our understanding of collision factors and information that could be useful in minimizing collision risks at future tower sites. Therefore, the mortality data collected at the KQLF tower site is of value, even with low mortality numbers.

Currently, it is difficult to predict the relative risk of bird collisions for a proposed communication tower site. With the KQLF tower study, only a two-year "snapshot" is provided by the monitoring study, and certainly a question as to how these results relate to the long-term risk is important. Unfortunately, few studies have reported long-term monitoring trends. Morris et al. (2003) reported annual variation of bird mortalities at three television towers in New York and one in Ohio (ranging from 855 to 1,000 ft in tower height) between 1970 and 1999, with the number of birds collected each year per tower ranging from 0 to 3,305, and a marked decline in the number of birds killed in the 1990s. Crawford and Engstrom (2001) reported a range of bird mortalities for a tower that was initially constructed at 670 ft and subsequently rebuilt to 1,010 ft. Of the

44,007 birds recorded over a 29-year period, one of the longest avian monitoring projects in the U.S., annual bird mortality numbers ranged from 272 in 1980 to 4,358 in 1957. Another 38-year study in Tennessee reported the number of birds collected at a 1,368 ft television tower to range by decade from almost 12,000 birds in the 1960's to just over 600 birds in the 1990's (Nehring and Bivens 1999). The reason for the decline in the number of bird mortalities reported for communication tower sites across the U.S. in the last two decades is unknown, but theories include a decline in migratory bird populations, an increase in urban and suburban lighting, a selection against low flying migrants, an increase in scavenging of carcasses at tower sites, a change in weather patterns, or a combination of factors.

5.2.3 Other Factors Affecting Mortality Risk

The height at which birds fly is likely an important factor affecting collisions. Figure 6 depicts the altitudinal ranges by bird group and relative abundance. In migration, larger birds such as waterfowl and cranes generally fly at high altitudes; however, inclement weather and limited visibility generally force birds to fly lower, thereby potentially correlating increased bird mortalities at communication tower sites with inclement weather, seasonal frontal movements, and reduced visibility.

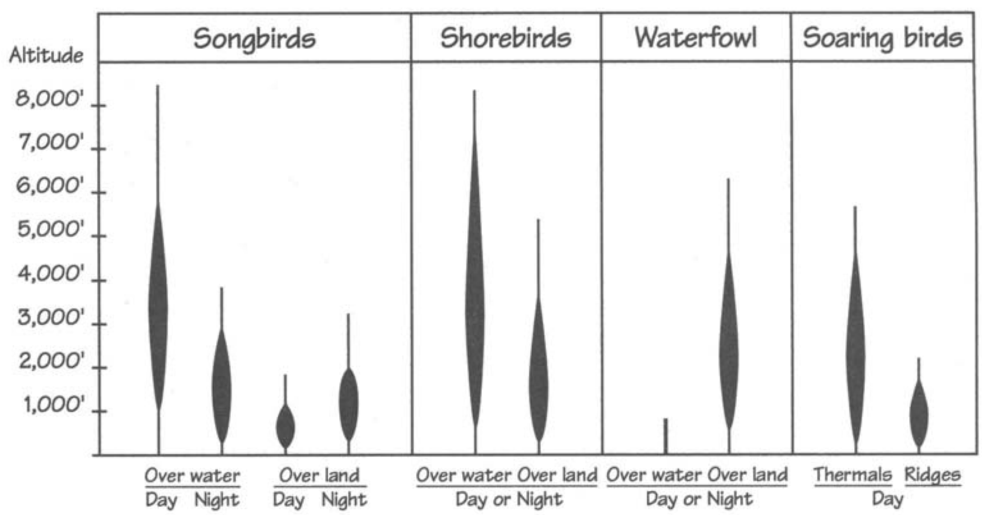


Figure 6. Relative altitudes of migrating birds (from Kerlinger 1995).

Few in-depth behavioral studies on migratory bird behavior have been completed at communication tower sites. However, a number of observations have been recorded by researchers that provide insight into attraction or avoidance of tower sites under varying environmental conditions (Cochran and Graber 1958; Stoddard 1962; Taylor and Anderson 1973; Avery et al. 1975, 1976; Larkin and Frase 1988; Nehring and Bivens 1999; Gauthreaux and Belser 2000). Different species' migration patterns (e.g., flying altitudes, routes, social behavior) may result in certain species being at a greater risk of collision. Stoddard (1962) also documented large numbers of birds migrating at higher altitudes above a tower with no resulting mortalities, except when inclement weather forced the birds to fly at lower altitudes.

No information on existing bird flight patterns, movements, or flight behavior was available for the KQLF study. In order to document baseline conditions for both migratory and resident bird movements and flight patterns, radar coverage would be necessary. However, radar coverage is sporadic in the western U.S. and can be expensive to implement, as discussed in Section 5.3.3. Gauthreaux and Belser (2003) describe how different radars can be used to detect bird movements and flight patterns, but to date, only one study has used radar tracking to document flight patterns of migrating birds near a 1,010 ft broadcasting tower (Larkin and Frase 1988). Radar, though, holds promise because advancements in radar technology coupled with knowledge from monitoring studies may make it more feasible to "survey" sites using radar prior to selecting tower sites and, thus, select sites with a lower potential risk of avian collision and mortality.

5.2.4 Correlations with Weather

Most moderate to large bird kills at tower sites have occurred during or following a storm event or frontal system, particularly during migration. The correlation between bird kills and advancing cold fronts with lower cloud ceilings, increased winds, and lower visibility appears to be strong, particularly during autumn (Brewer and Ellis 1958; Norwoods 1960; Eaton 1967; Avery et al. 1977; Mollhoff 1983; Nicholson 1984; Kemper 1996). Many of these studies suggest a direct correlation between bird collision risks and weather events; however, the extent or degree of this association and how other factors may influence mortality rates are essentially unknown.

Correlations between weather conditions and the bird mortalities recorded for the KQLF tower site are limited, because of the small number of bird mortalities recorded.during the 2-year study. However, precipitation, wind, and reduced visibility did precede all 11 mortality recordings. As stated, this information provides anecdotal information about the local weather patterns and avian mortality events for this area of Colorado. As evident by the variation in weather patterns recorded (Appendix B), there is no "typical" pattern or trend. Considering the year-to-year variation in weather patterns along the Front Range of Colorado, this makes predicting future risks much more difficult.

5.2.5 Biases in Avian Mortality Estimates

In this study, incorporating the scavenger removal and surveyor bias results did increase the estimated number of bird mortalities from 11 to 39 over the 2-year period. This number of mortalities is considered to be low compared to mass mortalities at other communication tower sites.

Although few avian studies at communication tower sites have incorporated scavenger removal studies, estimates of scavenging rates can provide more reliable estimates of collision rates at communication towers. Without incorporating scavenger removal rates, relatively small kills (10 to 50 birds) could be masked by scavengers (Crawford and Engstrom 2001) and mortality numbers may be under-represented. For example, in this study almost all birds would be expected to be removed within a week during early fall migration.

Decay rates and carcass smells increase with higher temperatures, and scavenging rates also would be expected to correspondingly increase. In the fall, predator numbers are greater because of young born during the previous spring/summer. In temperature zones, such as Colorado, a decrease in decay and thus detection would be expected from late fall through early spring, especially as predator numbers decline over the winter months. In late spring, a combination of increasing temperatures and new young of predators would then be expected to increase scavenging rates. The variation in scavenging rates by season from this study suggests that it may be important to include additional surveys in order to improve estimation of seasonal scavenging rates and ultimately better estimates of seasonal collision mortality below towers. Unfortunately, a difficulty with scavenging surveys is that, if conducted at the tower site, they may attract predators and thus further increase scavenging rates. This is less of an issue if similar nearby habitats can be used for the scavenging surveys.

Similarly, incorporating surveyor bias can provide a more accurate estimate of avian collision mortality. Surveyor bias can occur because of differences in observers due to variations search efficiency and search images, which can result in carcasses being missed. For example, a mass kill occurred at a North Carolina tower on 4-5 September 1974 and resulted in the recovery of 3,200 bird carcasses, but the estimate of undetected carcasses was in the thousands because of dense vegetation and loss to scavengers and predators (Carter and Parnell 1978). An area searched by two individuals was subsequently re-examined by a third surveyor, and an additional 500 birds were discovered .

5.3 Recommendations

As part of the FCC's review of avian collisions at communication towers, several recommendations are being examined with regard to bird collisions at tower sites (FCC 2004). Many of the recommendations are interrelated and interdependent and reflect concerns and questions identified from public comments and responses, industry input, and ongoing dialog with the Communication Tower Working Group. Because many of these suggested recommendations also are complex and potentially controversial, future application of specific measures should pertain to the specific project analyzed, be delineated in detail, and adhere to regulatory requirements and methods that are scientifically valid.

Two of the following recommendations are specific to Clear Channel's KQLF-FM radio broadcasting tower, based on the study's results and current knowledge and emphasis regarding avian collision risks at tower sites. The third recommendation is more general, does not pertain to the KQLF tower site, and has been developed for the benefit of Larimer County for future project reviews and decision-making.

5.3.1 Clear Channel Mortality Reporting

It is recommended that Clear Channel voluntarily record any avian mortalities detected at the tower site. This information would not only provide incidental mortality information, it also would document any large mortality events, if they were to occur at this location. EDM would be willing to facilitate and support future monitoring in order to collect additional data and further the understanding of tower and bird interactions. Clear Channel's notification of mortality events and access to the tower site would be voluntary, but (if implemented) would support ongoing dialog among avian researchers, the communication industry, and the FCC to help answer outstanding questions regarding communication tower operation in the western U.S.

5.3.2 KQLF Tower Lighting

Nocturnal migrating birds are thought to be attracted to artificial light sources on communication towers (see Section 1.2). Two aspects of tower lighting have been identified as possibly attracting birds, including color (white lights, ultraviolet, or specific wavelengths) and light duration (strobes, flashing, or steady). Some studies and several anecdotal reports suggest that white strobe lights may be less attractive to birds, including Gauthreaux and Belser (2000), which demonstrated a greater proportion of bird attraction to red flashing incandescent lights than to white strobes. The impact of different lighting schemes on migratory birds continues to be investigated.

Although additional research is needed on the types of tower lighting relative to other factors that increase or decrease the risk of bird collisions with communication towers, the current USFWS' lighting recommendations in their voluntary interim guidelines (USFWS 2000) area as follows:

> "Unless otherwise required by the FAA, only white (preferable) or red strobe lights should be used at night, and these should be the minimum number, minimum intensity, and minimum number of flashes per minute (longest duration between flashes) allowable by the FAA. The use of solid red or pulsating red warning lights at night should be avoided."

As discussed in Chapter 2.0, the lighting regime for the KQLF-FM broadcasting tower was based on public input received during the county scoping meetings and permitting process as per applicable FAA regulations. Local residents were opposed to white strobe lights at night because of aesthetics concerns. Based on current information, the use of white strobe lights at night could reduce the potential future attraction of birds in and near the KQLF tower site.

It is recommended that, if possible, the County allow Clear Channel to use white strobe lights at night. Since the white strobe lights are currently installed on the tower, it is assumed that no modifications to lighting hardware would be required, and Clear Channel could easily switch the night lighting. Therefore, modifying the night lighting to white strobes could reduce the potential risk of future bird mortalities, particularly during inclement weather. This modification to the County permit may require public input, however, given the initial public concerns regarding the visual influences.

5.3.3 Future Tower Siting Review and Standardized Methods

Further studies in this region are needed at other locations in order to understand the overall pattern of avian mortalities at communication tower sites in Colorado and surrounding areas. For example, it is not understood how migration patterns of birds along the foothills vary from the plains or mountains and how flight patterns vary over short distances.

If future communication tower studies are implemented, it is important that relevant data are collected in a standard or systematic process that allows for comparison with other tower studies. Standardized methods and metrics should be based on applicable studies at that time, as methodologies continue to evolve. It also is important to identify and incorporate variables that could affect avian mortalities such as tower lighting, guy wires, height, and location (e.g., geography and topography). Thus it will be important to maintain communication with relevant entities such as the FCC, applicable researchers, and the communication industry to ensure that the most appropriate approaches are used in future data collection and monitoring of tower projects in Larimer County. Standardization also will allow Larimer County to compare future study results to the KQLF study and other representative tower studies in order to draw applicable conclusions.

It also would be advantageous to work with avian organizations such as the Audubon Society and Rocky Mountain Bird Observatory to establish baseline information on bird densities, movements, altitudes, and behaviors during migration in proximity to tower sites. If bird mortality, corrected for study biases, is monitored at a site at the same time as bird abundance is monitored then the relationship between mortality and abundance can be established and risk factors can be developed.

Radar can provide valuable information pertaining to bird movement and direction, overall bird densities during migration, flight altitudes, and flocking behavior. As this technology continues to advance, use of radar may become more economical to monitor bird movement in proximity to proposed or existing tower sites.

In summary, Clear Channel’s KQLF-FM broadcasting tower study in northern Larimer County has provided valuable information and insight into avian interactions with a 500-foot radio tower and antennae at this location. Mortality numbers recorded during the 2-year monitoring period were low, even when adjusting for scavenger removal and surveyor biases. These data can assist Larimer County in future tower siting and review projects, particularly as more information becomes available on this issue in the U.S.

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APPENDIX A
TOWER SURVEY RESULTS 2002-2004

Clear Channel Communication Tower 2002 Data Summary

Entry No.	Date	ID	Time	Line Transect	Transect Distance	Perp. Distance	Line Side	Species	Comments	Temp (°F)	CC (%)	Wind (mph)	Time Start	Time Stop	Surveyor
1	2-Jul-2002								none found	85-90	20	10	9:15	13:05	RM
2	9-Jul-2002								none found	86	20	10-15	10:45	14:53	RM
3	16-Jul-2002								none found	88	0	0-10	9:00	13:00	RM
4	23-Jul-2002								none found	70	60	5	9:10	13:15	RM
5	30-Jul-2002								none found	75	0	10-15	8:06	12:01	RM
6	6-Aug-2002				No data sheet				none found	72	8	10-15	8:00	11:47	RM
7	13-Aug-2002								none found	56	0	5-10	9:07	12:15	RM
8	20-Aug-2002								none found	54	90	25-30	8:00	11:30	RM
9	26-Aug-2002								none found	92	1	5	11:10	15:45	RM
10	2-Sep-2002								none found	80	0	5-10	13:42	16:30	RM
11	8-Sep-2002								none found	65	100	5-10	14:45	16:50	RM
12	12-Sep-2002	1	12:00	SE	11 m			American coot	juvenile; broken wing	62	50	0-15	11:50	12:20	QM
13	15-Sep-2002								none found	75	70	5-10	17:10	19:00	RM
14	23-Sep-2002								none found	75	60	5	17:05	19:10	RM
15	30-Sep-2002								none found	80	20	1	13:15	15:30	RM
16	8-Oct-2002								none found	65	40	5	16:00	17:55	RM
17	14-Oct-2002								none found	65	10	10	17:00	18:40	RM

Clear Channel Communication Tower 2002 Data Summary

Entry No.	Date	ID	Time	Line Transect	Transect Distance	Perp. Distance	Line Side	Species	Comments	Temp (°F)	CC (%)	Wind (mph)	Time Start	Time Stop	Surveyor
18	23-Oct-2002								60-m only-none found	20	100	1	17:00	18:00	RM
19	29-Oct-2002								none found	40	100	10	14:00	16:08	RM
20	5-Nov-2002								none found	35	0	20-30	15:00	17:00	RM
21	12-Nov-2002								none found	45	30	1-2	15:15	16:55	RM
22	19-Nov-2002								none found	50	10	20	15:00	16:40	RM
23	24-Nov-2002								none found	18	100	0	8:00	10:00	RM
24	2-Dec-2002								none found	54	0	2	13:00	14:57	RM
25	10-Dec-2002								none found	25	60	15	15:45	17:05	RM
26	18-Dec-2002								none found	25	10	2-5	14:00	16:50	RM

Clear Channel Communication Tower
2003 Data Summary

Entry No.	Date	ID	Time	Line Trans	Transect Distance	Perp. Distance	Line Side	Species	Comments	Precipitation	Temp (°F)	CC (%)	Wind (mph)	Time Start	Time Stop	Surveyor
1	17-Jan-2003								none found		20	0	35~50	15:00	16:45	RM
2	25-Jan-2003								none found		15	10	30	11:00	14:15	RM
3	1-Feb-2003								none found		50	50	10~15	13:40	15:40	RM
4	8-Feb-2003								none found		25	50	30	12:00	14:45	RM
5	15-Feb-2003								none found		45	10	1~2	11:00	13:40	RM
6	22-Feb-2003								none found		45	0	5~10	13:00	13:20	RM
7	1-Mar-2003								none found		30	100	1-2	14:00	16:00	RM
8	10-Mar-2003								none found		60	0	1-2	12:00	17:55	RM
9	17-Mar-2003								none found	high wind and rain	30	100	10-20	15:30	17:26	RM
10	22-Mar-2003								none found		65	10	1-2	12:00	14:15	RM
11	30-Mar-2003								none found	intermittent snow	25	100	1-2	16:00	18:05	RM
12	6-Apr-2003								none found		55	0	5-10	15:00	17:10	RM
13	13-Apr-2003								none found		30	0	30-40	15:50	17:40	RM
14	20-Apr-2003								none found		40	20	40-50	15:45	18:00	RM
15	27-Apr-2003	1	18:00	SE	50 m			Lincoln's sparrow			40	50	10	16:20	18:35	RM
16	4-May-2003	1	16:55	SE	11 m			Common grackle	feathers only		48	40	50-55	16:40	18:55	RM
17	12-May-2003	1	18:10	NE	30 m			Swainson's thrush	NE guy wires[1]		65	30	0	17:45	18:30	KW

Clear Channel Communication Tower
2003 Data Summary

Entry No.	Date	ID	Time	Line Trans	Transect Distance	Perp. Distance	Line Side	Species	Comments	Precipitation	Temp (°F)	CC (%)	Wind (mph)	Time Start	Time Stop	Surveyor
18	23-May-2003								none found		75	30	10-15	13:00	14:45	NB
19	27-May-2003	1		SW	45 m			Swainson's thrush			82	0	10-15	14:55	15:05	QM
20	30-May-2003								none found		65	100	10-15	10:40	12:45	JC
21	6-Jun-2003	1	13:55	NW	30 m			Brewer's sparrow			60	90	5-10	13:45	15:45	NB
22	13-Jun-2003								none found		65	75	5-10	10:00	11:45	JC
23	20-Jun-2003								none found		70	30	0-5	10:00	12:30	NB
24	27-Jun-2003	1	9:50	SE	40 m			Yellow-headed blackbird	wing only		68	5	20-25	9:00	11:06	ST
25	3-Jul-2003								none found		70	5	5	10:25	12:17	ST
26	12-Jul-2003								none found		75	5	10	10:45	12:50	ST
27	18-Jul-2003								none found		85	40	0-5	13:00	15:15	NB
28	25-Jul-2003								none found		75	40	20-25	9:55	12:10	JC
29	1-Aug-2003								none found		70	5	5-10	9:25	11:35	JC
30	8-Aug-2003								none found		65	95	5-10	10:00	12:05	JC
31	15-Aug-2003								none found		65	5	5-10	9:45	11:40	JC
32	22-Aug-2003								none found		60	40	0-5	9:05	11:05	JC
33	1-Sep-2003	1	11:25	NE	32 m			House wren			70	0	0-5	11:05	12:55	NB

Clear Channel Communication Tower
2003 Data Summary

Entry No.	Date	ID	Time	Line Trans	Transect Distance	Perp. Distance	Line Side	Species	Comments	Precipitation	Temp (°F)	CC (%)	Wind (mph)	Time Start	Time Stop	Surveyor
34	8-Sep-2003								none found		70	10	0-5	11:15	13:10	NB
35	15-Sep-2003	1	15:26	NE	40 m			Mourning warbler	first plumage; sex unknown		75	2	5-10	15:00	17:00	NB
36	22-Sep-2003	1	7:19	SE	52 m			Unknown	near cement blocks; feather spot		45	5	0-5	7:00	9:05	NB
37	29-Sep-2003								none found		45	5	10	9:25	11:05	NB
38	7-Oct-2003								none found		72	40	0-5	15:00	16:50	NB
39	13-Oct-2003								none found		45	60	30-40	15:00	17:20	NB
40	22-Oct-2003								none found		72	0	0-5	14:30	16:15	NB
41	27-Oct-2003								none found		55	90	30-50	11:00	13:20	NB
42	30-Oct-2003								none found; east transects not surveyed due to ice	slight drizzle	25-30	100	0-5	14:55	16:10	NB
43	31-Oct-2003								none found; only surveyed 60-meter area due to icy conditions	dense fog, drizzle, snow & ice cover	20	100	5-10	15:30	16:00	NB
44	3-Nov-2003								none found	dense fog, ice and snow cover	35	100	0	15:20	16:10	NB
45	12-Nov-2003								none found		35-40	90	0-5	11:00	12:50	NB
46	18-Nov-2003								none found		40	70	30-40	11:00	13:10	NB
47	1-Dec-2003								none found		35	50	0	8:16	9:38	NB/SB-M

Clear Channel Communication Tower
2003 Data Summary

Entry No.	Date	ID	Time	Line Trans	Transect Distance	Perp. Distance	Line Side	Species	Comments	Precipitation	Temp (°F)	CC (%)	Wind (mph)	Time Start	Time Stop	Surveyor
48	8-Dec-2003								none found	light snow, starting to accumulate	25	100	5-10	7:00	9:22	NB/SB-M
49	15-Dec-2003								none found	part bare ground/ part light snow cover and part deep drift (>12 in)	20	100	30-40	10:42	12:57	SB-M
50	23-Dec-2003								none found	bare ground to > 1 in drifts	30	0	5-10	10:00	11:45	SB-M
51	30-Dec-2003								none found	snow free except west-facing slopes	30	90	10-20	8:03	9:36	SB-M

[1]Directly under the NE guy wires on the east side of a dirt berm.

Clear Channel Communication Tower
2004 Data Summary

Entry No.	Date	ID	Time	Line Trans	Trans Distance	Perp. Distance	Line Side	Species	Comments	Precipitation	Temp (°F)	CC (%)	Wind (mph)	Time Start	Time Stop	Surveyor
1	6-Jan-2004								none found	few inches of snow to > 1-foot drifts	20	0	0-5	10:22	11:58	SB-M
2	13-Jan-2003								none found	site mostly snow free (few patches on west slopes)	40	0	5-10	9:03	10:28	SB-M
3	20-Jan-2004								none found	light snow cover; some snow ice	30	100	0-5	8:58	10:16	SB-M
4	29-Jan-2004								none found	very few snow patches still on west slope	30	90	15-25	9:52	11:02	SB-M
5	5-Feb-2004								60-meter only; none found	snowing; whiteout conditions	20	100	5-10	9:37	10:13	SB-M
6	14-Feb-2004								none found	mostly snow free; few patches west slope	35	0	5-10	12:04	13:37	SB-M
7	21-Feb-2004								none found	mostly snow free	35	100	0-5	12:55	14:03	SB-M
8	28-Feb-2004								none found	no snow	20	100	5	12:13	13:27	SB-M
9	7-Mar-2004								none found	mostly snow free; few patches west slope	30	0	20-30	11:11	12:23	SB-M
10	13-Mar-2003								none found		40	50	20-30	8:50	9:47	SB-M/AT
11	20-Mar-2004								none found		55	0	20	10:30	12:01	AT
12	27-Mar-2004								none found		55	60	30	12:15	?	AT
13	30-Mar-2004								none found		60	0	25	12:30	1:02	AT

Clear Channel Communication Tower
2004 Data Summary

Entry No.	Date	ID	Time	Line Trans	Trans Distance	Perp. Distance	Line Side	Species	Comments	Precipitation	Temp (°F)	CC (%)	Wind (mph)	Time Start	Time Stop	Surveyor
14	4-Apr-2004								none found	cloudy rainy; weekly survey and 1 day after a 2-day storm event	60	30	10	2:05	3:25	AT
15	12-Apr-2004								none found		45	0	20	2:33	3:42	AT
16	17-Apr-2004								none found		70	40	10	1:40	2:45	AT
17	25-Apr-2004								none found		60	15	10	2:15	3:37	AT
18	1-May-2004								60-meter only; none found		50	60	20	10:13	10:35	AT
19	8-May-2004								none found		70	80	10	9:30	11:30	ST
20	14-May-2004								60-meter only; none found		60	50	15	13:35	14:20	ST
21	17-May-2004								none found	thunderstorm moved in as finished	70	75	20	14:25	16:15	ST
22	22-May-2004								none found		65	35	15-20	9:45	11:30	ST
23	29-May-2004	1	10:31	SE		10 m		Swainson's thrush			65	95	25+	10:15	12:00	ST
24	5-Jun-2004								none found		75	10	15	11:45	13:30	ST
25	11-Jun-2004								none found		62	75	30	12:40	14:45	ST
26	19-Jun-2004								none found		56	50	5	14:30	16:25	ST
27	26-Jun-2004								60-meter only; none found	thunderstorm moved over tower	60	80	5-10	13:00	13:30	ST
28	3-Jul-2004								none found		75	1	0-5	10:15	12:22	ST

APPENDIX B
RECORDED WEATHER CONDITIONS

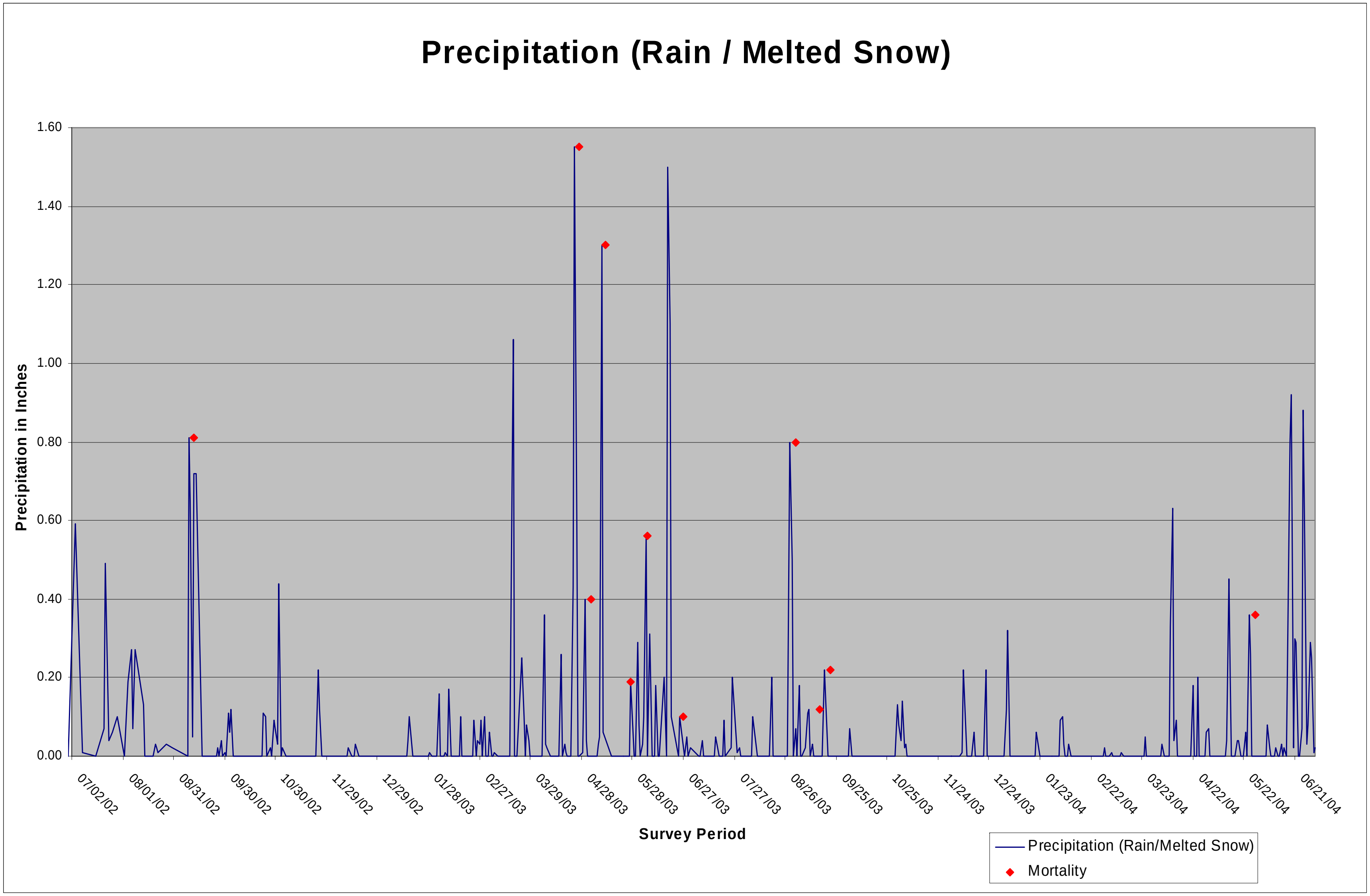

Figure B1 Precipitation recorded as rain or melted snow, from Virginia Dale, Colorado, weather station. Detection dates of avian mortalities are indicated by the red dots, and the dot height is the maximum precipitation value since the previous survey period.

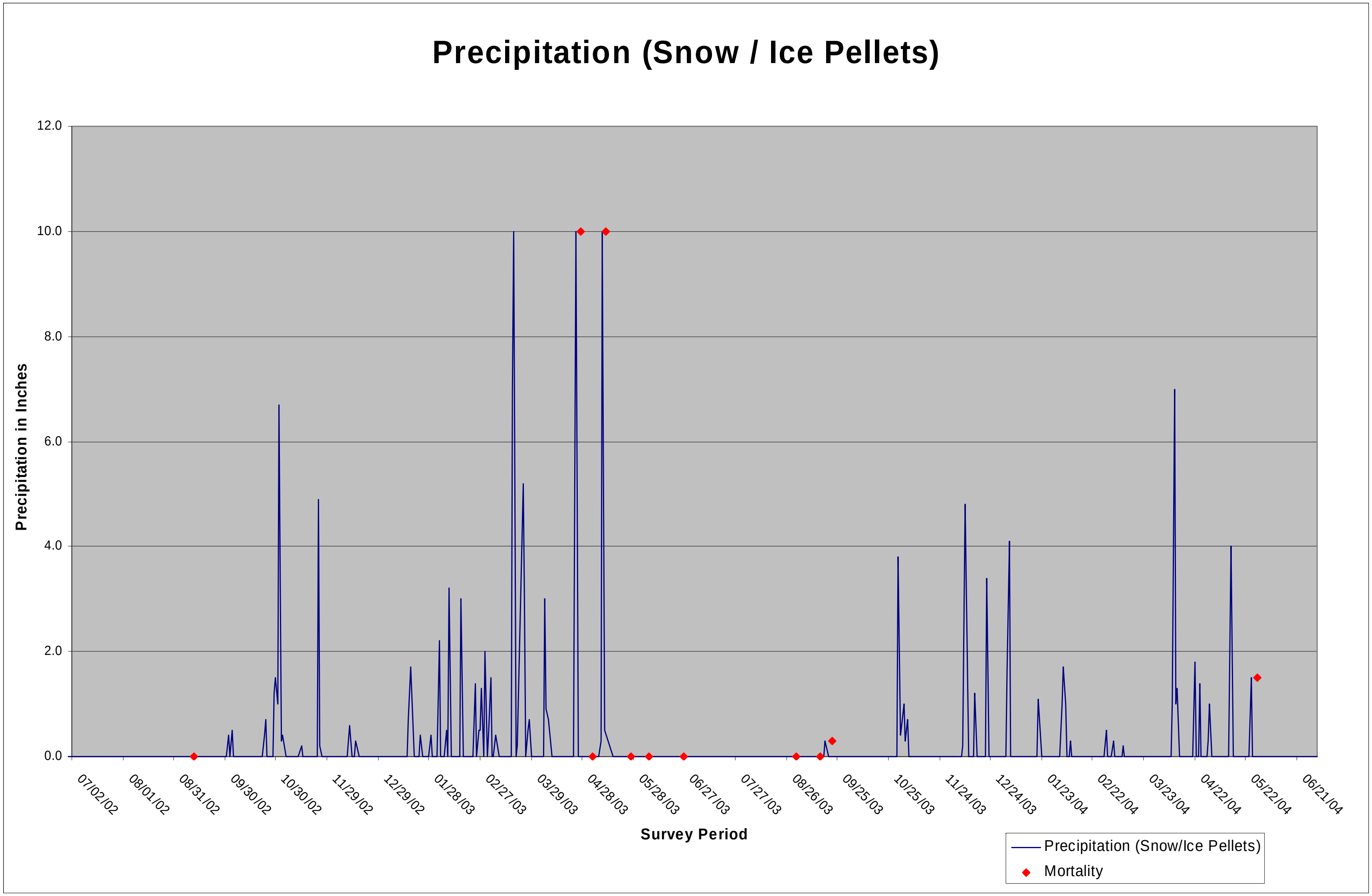

Figure B2 Precipitation recorded as snow or ice pellets, from Virginia Dale, Colorado, weather station. Detection dates of avian mortalities are indicated by the red dots, and the dot height is the maximum precipitation value since the previous survey period.

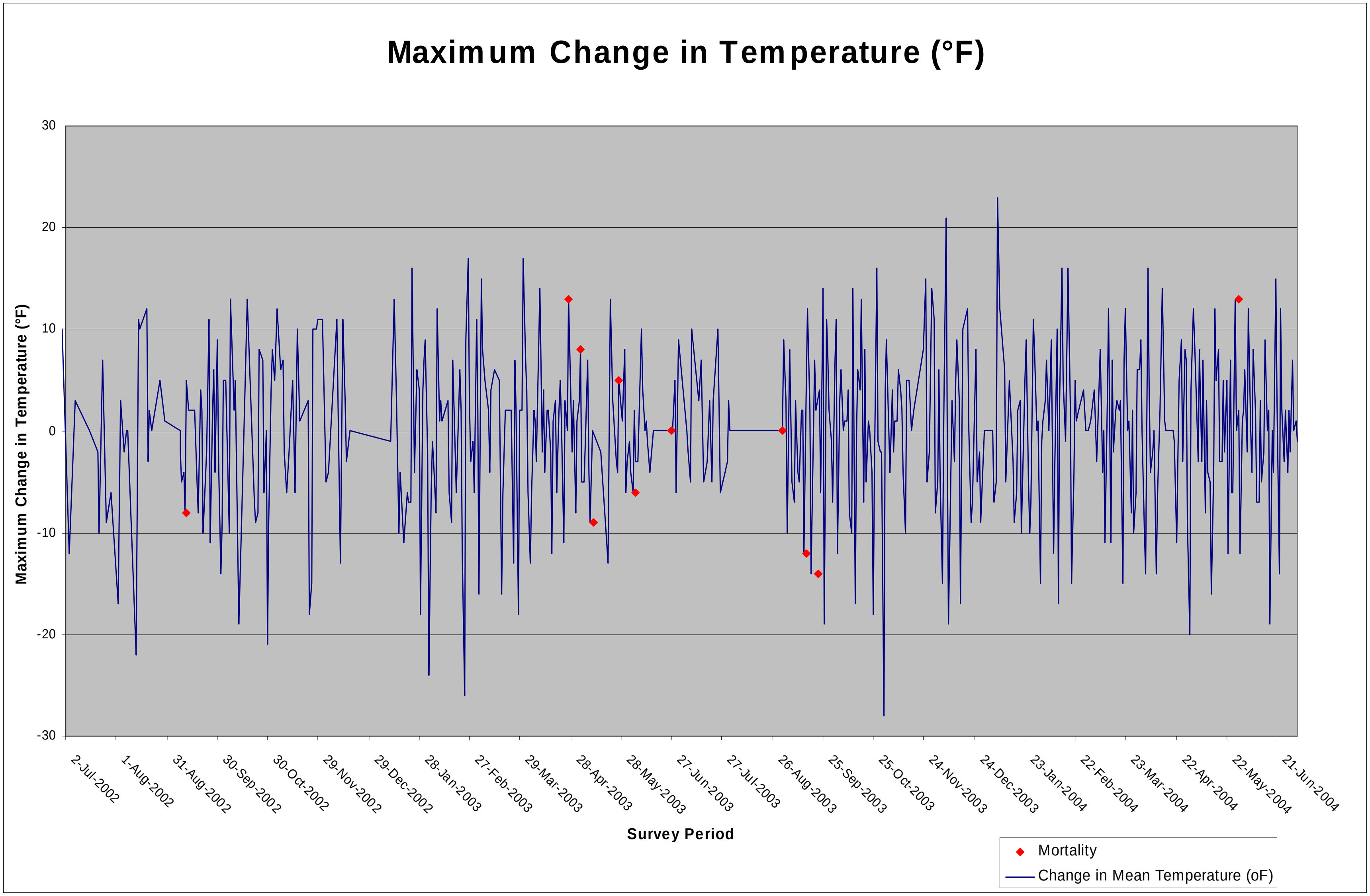

Figure B3 Maximum recorded change in temperature from Virginia Dale, Colorado, weather station. Detection dates of avian mortalities are indicated by the red dots, and the dot height is the maximum change in temperature since the previous survey period.

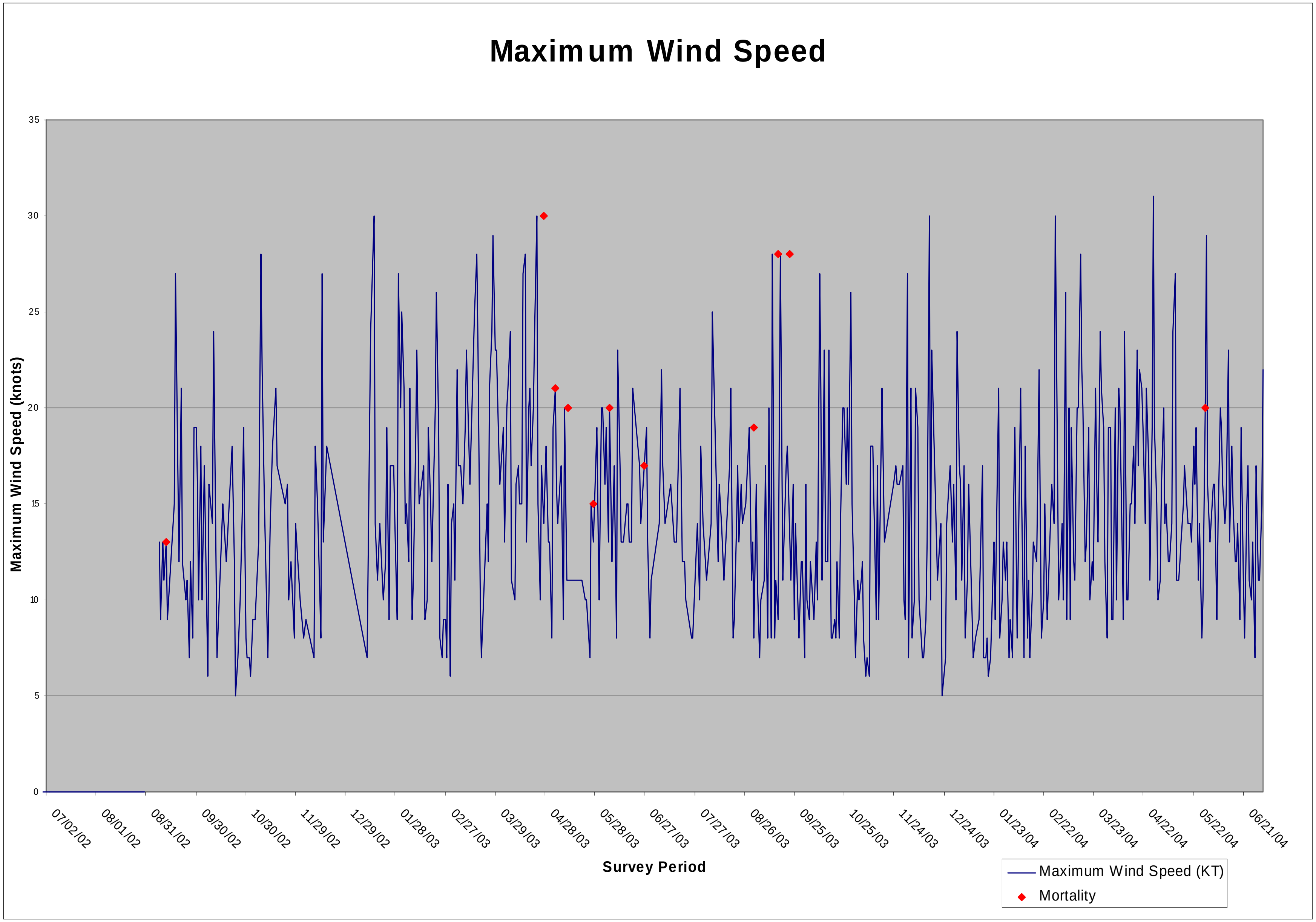

Figure B4 Maximum wind speed recorded at the Fort Collins-Loveland Airport weather station. Detection dates of avian mortalities are indicated by the red dots, and the dot height is the maximum wind speed since the previous survey period.

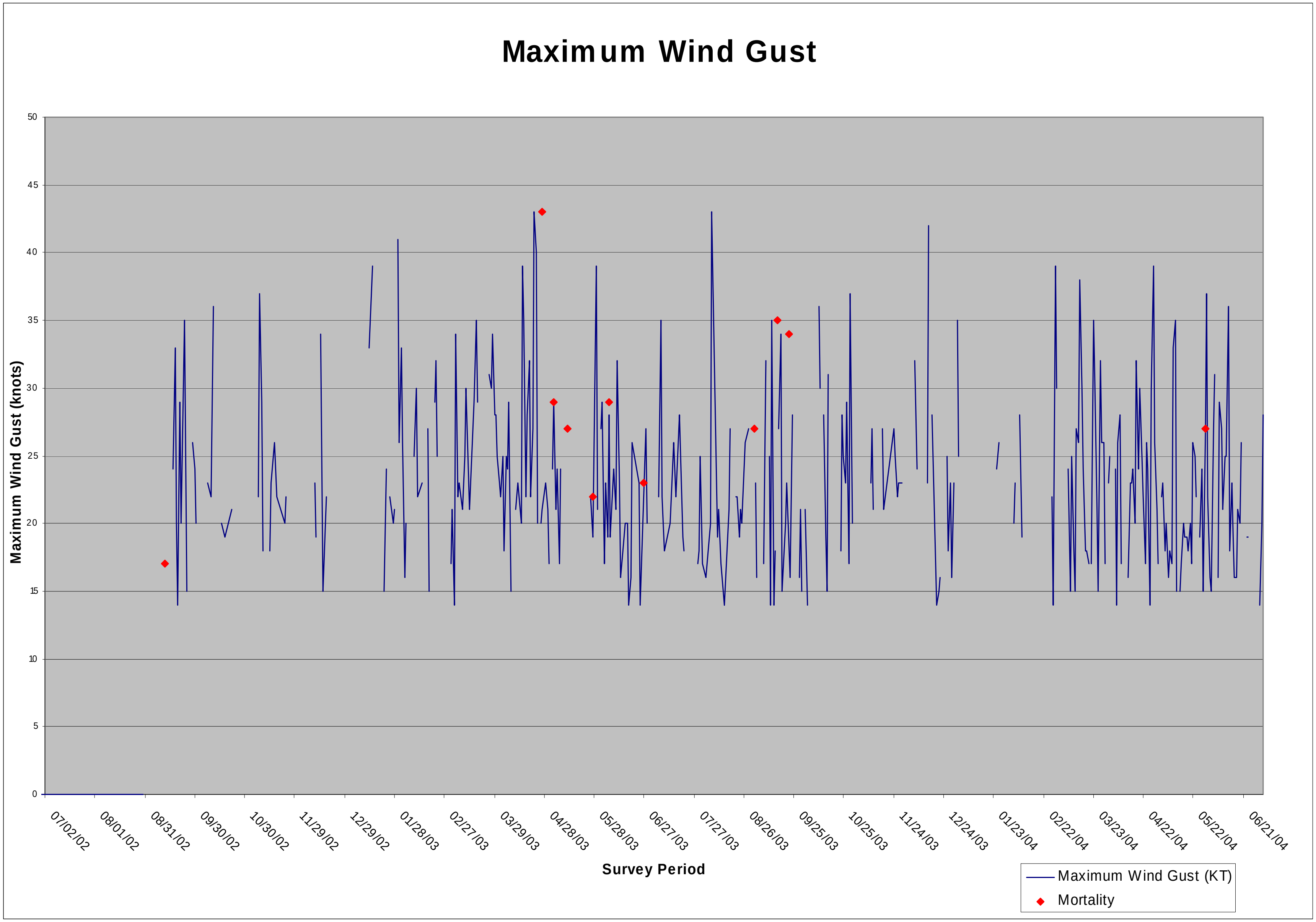

Figure B5 Maximum wind gusts recorded at the Fort Collins-Loveland Airport weather station. Detection dates of avian mortalities are indicated by the red dots, and the dot height is the maximum wind gust since the previous survey period.

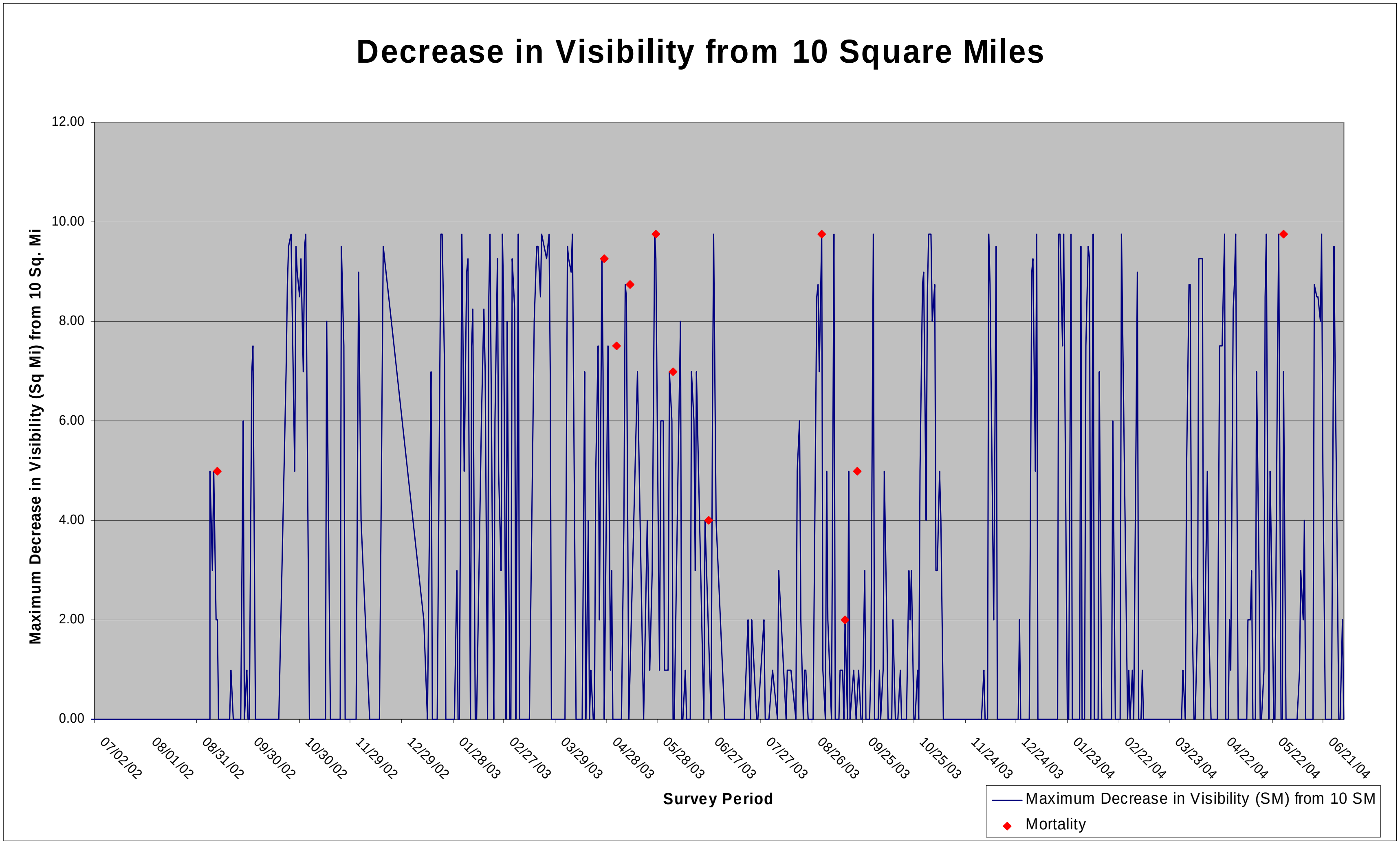

Figure B6 Decrease in visibility recorded at the Fort Collins-Loveland Airport weather station. Detection dates of avian mortalities are indicated by the red dots, and the dot height is the maximum decrease in visibility since the previous survey period.

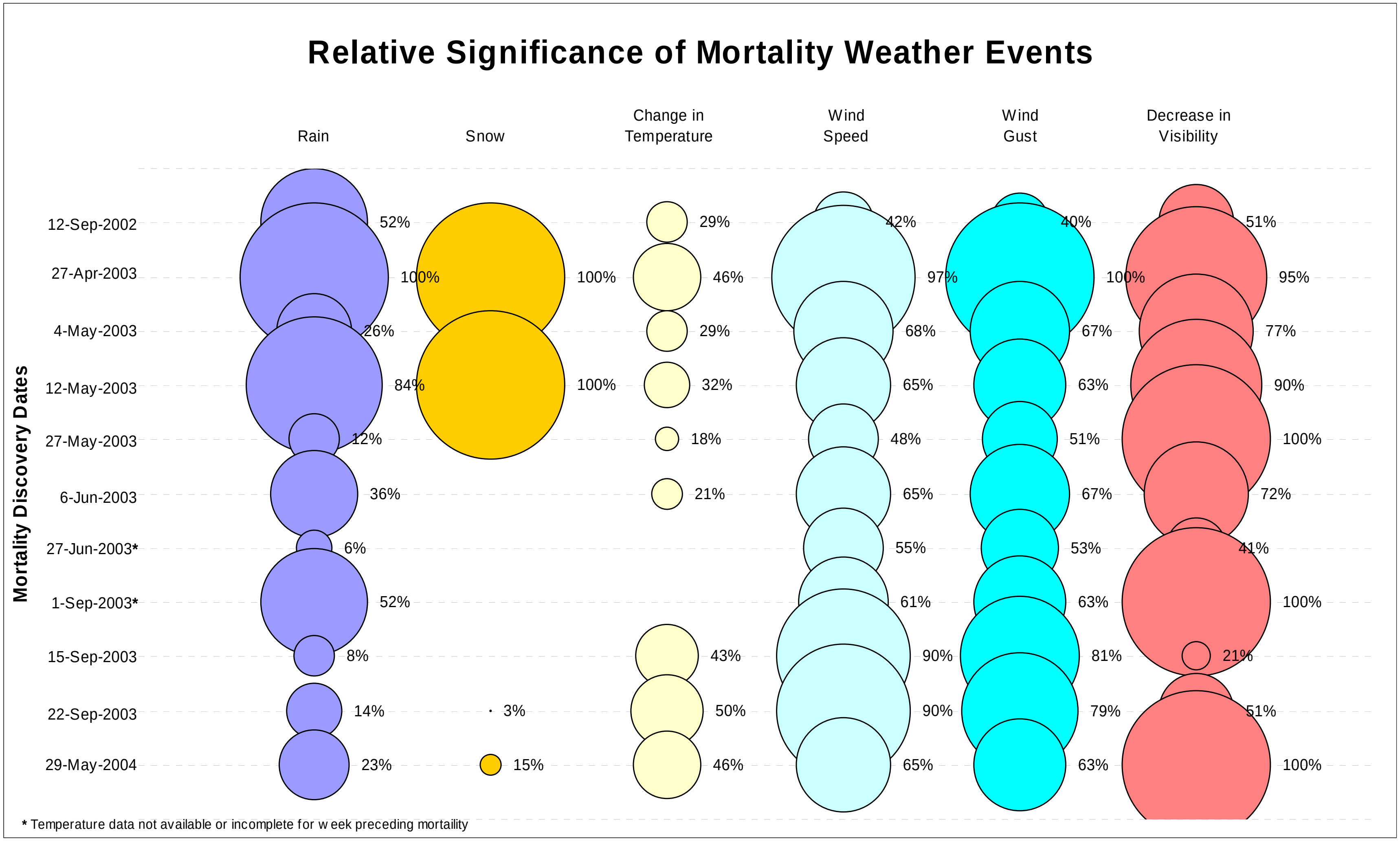

Figure B7 Relative significance of mortality weather events relative to the overall maximum. The size of each bubble indicates the value of a weather measure as a percentage of the largest value recorded over the study period.

APPENDIX C
REFERENCE SITE SURVEY RESULTS 2002-2004

Clear Channel Communication Reference Site
2002 Data Summary

Entry No.	Date	ID	Time	Line Transect	Transect Distance	Perp. Distance	Line Side	Species	Comments	Temp (°F)	CC (%)	Wind (mhp)	Time Start	Time Stop	Surveyor
1	15-Sep-2002								none found	80	60	5-10	14:55	16:50	RM
2	23-Sep-2002								none found	80	40	5-10	15:00	16:40	RM
3	30-Sep-2002								no survey conducted						RM
4	8-Oct-2002								none found	70	10	5	13:20	15:45	RM
5	14-Oct-2002								none found	70	40	5-10	15:05	16:50	RM
6	21-Oct-2002								none found	30	100	1	17:15	18:40	RM
7	29-Oct-2002								partial survey	40	1	10	12:00	13:30	RM
8	5-Nov-2002								none found	40	0	5-10	13:10	14:40	RM
9	12-Nov-2002								no survey conducted						
10	19-Nov-2002								none found	60	0	5	13:30	14:45	RM
11	24-Nov-2002								none found	25	100	1-2	10:20	11:58	RM
12	2-Dec-2002								no survey conducted						
13	10-Dec-2002								none found	30	30	5-10	13:50	15:20	RM
14	18-Dec-2002								no survey conducted						

Clear Channel Communication Reference Site
2003 Data Summary

Entry No.	Date	ID	Time	Line Transect	Transect Distance	Perp. Distance	Line Side	Species	Comments	Precipitation	Temp (°F)	CC (%)	Wind (mhp)	Time Start	Time Stop	Surveyor
1	17-Jan-2003								no survey conducted							RM
2	25-Jan-2003								none found		25	10	10-15	14:40	16:30	RM
3	1-Feb-2003								none found		55	30	40-45	11:00	13:10	RM
4	8-Feb-2003								none found		15	100	40	9:55	11:30	RM
5	15-Feb-2003								none found		40	20	5	8:50	10:30	RM
6	22-Feb-2003								none found		45	0	5-10	10:45	12:35	RM
7	1-Mar-2003								none found		30	20	1-2	15:00	13:15	RM
8	10-Mar-2003								no survey conducted							
9	17-Mar-2003								no survey conducted							
10	22-Mar-2003								none found		65	10	1-2	10:00	11:45	RM
11	30-Mar-2003								none found		25	100	1-2	14:00	15:45	RM
12	6-Apr-2003								none found		60	0	1-2	13:30	14:40	RM
13	13-Apr-2003								none found		40	0	10-20	14:10	15:30	RM
14	20-Apr-2003								none found		45	20	40-50	13:00	14:50	RM
15	27-Apr-2003								partial survey; none found		55	50	1-2	14:30	15:45	RM

Clear Channel Communication Reference Site
2003 Data Summary

Entry No.	Date	ID	Time	Line Transect	Transect Distance	Perp. Distance	Line Side	Species	Comments	Precipitation	Temp (°F)	CC (%)	Wind (mhp)	Time Start	Time Stop	Surveyor
16	4-May-2003								none found		48	30	40-50	14:45	16:05	RM
17	12-May-2003								no survey conducted							KW
18	23-May-2003								none found		75	30	0-5	15:30	17:10	NB
19	27-May-2003								no survey conducted							QM
20	30-May-2003								no survey conducted							JC
21	6-Jun-2003								no survey conducted	stormy weather						NB
22	13-Jun-2003								none found		75	100	0-5	12:15	13:45	JC
23	20-Jun-2003								none found		75	50	0-5	13:00	15:00	NB
24	27-Jun-2003								none found		75	5	10-15	11:30	13:00	ST
25	3-Jul-2003								none found		75	20	5	12:30	14:00	ST
26	12-Jul-2003								none found		80	20	10	13:35	14:50	ST
27	18-Jul-2003								none found		85	80	0-5	15:45	17:30	NB
28	25-Jul-2003								partial survey; none found		80	100	0-5	12:30	13:25	JC
29	1-Aug-2003								none found		75	10	5	12:00	13:20	JC
30	8-Aug-2003								none found		75	30	0-5	12:30	13:50	JC

Clear Channel Communication Reference Site
2003 Data Summary

Entry No.	Date	ID	Time	Line Transect	Transect Distance	Perp. Distance	Line Side	Species	Comments	Precipitation	Temp (°F)	CC (%)	Wind (mhp)	Time Start	Time Stop	Surveyor
31	15-Aug-2003								none found		80	5	5-10	12:10	13:25	JC
32	22-Aug-2003								none found		80	20	0-5	11:30	12:45	JC
33	1-Sep-2003								none found		75	0	0-5	13:20	15:00	NB
34	8-Sep-2003								none found		78	30	0-5	13:40	15:20	NB
35	15-Sep-2003								none found		70	5	10-15	17:30	19:00	NB
36	22-Sep-2003								none found		55	10	0-5	9:40	11:05	NB
37	29-Sep-2003								none found		45	5	10	9:25	11:05	NB
38	7-Oct-2003								none found		68	70	0-5	17:15	18:30	NB
39	13-Oct-2003								partial survey (3/4); none found		45	70	20	17:50	18:30	NB
40	22-Oct-2003								none found		70	0	0-5	16:45	18:20	NB
41	27-Oct-2003								none found		50-55	80	30	13:50	15:30	NB
42	30-Oct-2003								no survey; focus on additional tower surveys due to fog	slight drizzle						NB

Clear Channel Communication Reference Site
2003 Data Summary

Entry No.	Date	ID	Time	Line Transect	Transect Distance	Perp. Distance	Line Side	Species	Comments	Precipitation	Temp (°F)	CC (%)	Wind (mhp)	Time Start	Time Stop	Surveyor
43	31-Oct-2003								no survey; focus on additional tower surveys due to fog	dense fog, drizzle, snow & ice cover						NB
44	3-Nov-2003								no survey; focus on additional tower surveys due to fog	dense fog, ice and snow cover						NB
45	12-Nov-2003								none found		35	80	0-5	13:30	15:00	NB
46	18-Nov-2003								none found		40-45	50	30-40	13:40	15:10	NB
47	1-Dec-2003								none found		35	50	0	10:12	11:00	NB/SB-M
48	8-Dec-2003								none found	snow accumulating	30	100	5-10	9:50	10:24	NB/SB-M
49	15-Dec-2003								none found	ground covered w/ ≈ 0.5 in snow	30	25-50	gusty	13:23	14:19	SB-M
50	23-Dec-2003								none found	patchy snow up to 1 inch	35-42	0	0-5	12:06	13:17	SB-M
51	30-Dec-2003								none found	no snow	30	90	40+	10:11	11:15	SB-M

Clear Channel Communication Reference Site
2004 Data Summary

Entry No.	Date	ID	Time	Line Transect	Transect Distance	Perp. Distance	Line Side	Species	Comments	Precipitation	Temp (°F)	CC (%)	Wind (mhp)	Time Start	Time Stop	Surveyor
1	6-Jan-2004								none found	some bare ground; most snow covered	20	90	0-5	12:36	13:50	SB-M
2	13-Jan-2004								none found	no snow	40	0	0-5	10:56	11:50	SB-M
3	20-Jan-2004								none found	snowing; some ground cover	30	100	0	10:49	11:50	SB-M
4	29-Jan-2004								none found		30	90	5-10	11:31	12:31	SB-M
5	14-Feb-2004								none found		40	0	0-5	13:51	14:30	SB-M
6	21-Feb-2004								none found		35	100	0-5	14:45	15:39	SB-M
7	28-Feb-2004								none found	no snow	20	100	5-10	13:47	14:53	SB-M
8	7-Mar-2004								none found	no snow	30-40	0	20-30	12:37	13:29	SB-M
9	13-Mar-2004								none found		50	0	0-5	10:25	11:07	SB-M/AT
10	20-Mar-2004								none found		65	0	10	12:35	13:37	AT
11	30-Mar-2004								none found		70	0	15	13:25	14:30	AT
12	4-Apr-2004								none found		65	10	10	15:45	16:55	AT
13	12-Apr-2004								none found		45	5	15	16:08	17:15	AT
14	17-Apr-2004								none found		70	70	10	15:10	16:15	AT

Clear Channel Communication Reference Site
2004 Data Summary

Entry No.	Date	ID	Time	Line Transect	Transect Distance	Perp. Distance	Line Side	Species	Comments	Precipitation	Temp (°F)	CC (%)	Wind (mhp)	Time Start	Time Stop	Surveyor
15	25-Apr-2004								none found		55	10	10	12:30	13:45	AT
16	8-May-2004								none found		75	65	15	12:10	13:20	ST
17	22-May-2004								none found		65	25	15-20	12:20	13:15	ST
18	29-May-2004								no survey conducted	incoming thunderstorm	55	100	30+	-	-	ST
19	5-Jun-2004								none found		79	75	10	14:15	?	ST
20	11-Jun-2004								none found		65	60	20-25	15:25	16:30	ST
21	26-Jun-2004								partial survey; none found	storm coming; left before finishing	65	25	0-5	11:00	12:00	ST